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and

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Routine and Other Tests

In a Paper to the Birmingham, Coventry and West Midlands Branch of the Institute of British Foundrymen last week, Mr. W. Y. Buchanan gave another of the contributions he has made to the science and art of testing moulding sands, a contribution that gives rise to some reflections on testing methods. For the purpose of daily foundry control of both process and product, various kinds of routine test are becoming increasingly used. One of the oldest is chemical analysis, and perhaps the oldest of all and most used is some form of mechanical test. Micro-examination is becoming more and more popular. The chill test is capable of giving quickly much of the information ordinarily derived from analysis. The life or fluidity test summarises the likelihood of the hot metal filling its mould satisfactorily. As we pointed out recently, some of these tests determine qualities or properties in an absolute sense. Thus there is little argument about analysis being able to determine, say, the silicon or phosphorus content. Other tests do not really measure an inherent property so much as a response to certain external conditions, as in heat, corrosion and erosion resistance tests.

For foundry control purposes the requirements stand out very clearly. A test should be simple, easily capable of interpretation, rapid, and it should be possible to carry it out by unskilled or only moderately skilled labour. It should be cheap to conduct if these requirements are met, both in material and in time, but it should also not require expensive apparatus. Now a test which fulfils these requirements is likely to have various drawbacks, because in effective compromise on these points the test fails to reflect the complexity of practical conditions for which it is required to act as an index. Thus, however a sand test-piece is prepared it is unlikely that it can reflect the variety of conditions in a single mould of varying sand thickness, or the variety of methods of ramming under which it may be used, by hand or by various types of machines. If a thermal expansion or a thermal conductivity is taken, the result will vary with temperature. The conclusion we draw is not that routine tests should be unduly complicated, but that research should reveal to us clearly the various limitations of a given type of test, so that it can be employed in full knowledge of these limitations, to prevent us being deceived through reading more into it than it is capable of bearing. Hence the value of such work as Mr. Buchanan is doing.

Difficulties of Definition

From time to time we are asked to define certain technical terms, and immediately difficulty is experienced because different interpretations are used by various sections of the industry or allied ones. For instance, "bottom pouring" has two different meanings when applied to a ladle and a mould, whilst if the mould be for the formation of an ingot the term "running uphill" is often used. "Life" admits of two entirely different interpretations when applied to an ingot mould and liquid metal, though unanimity has not been reached in the latter case as to its exact meaning where universal application is intended. "Soft" steel made by the crucible process is not necessarily of the same composition and physical properties as when manufactured by the open-hearth process. "Soundness" is a word difficult of definition, as some maintain that it is essentially the reciprocal of "unsoundness." Others would accord it a much wider interpretation and include within its ambit all properties easily assessed. A casting free from sectional unsoundness, but showing perhaps a serious surface blemish, a portion short-run, or obviously warped or otherwise dimensionally incorrect, would not deserve the appellation "sound." In each range of castings there is usually one property which is outstanding as being of paramount importance, and if the requisite standard has not been achieved in this particular direction, then it would fail to command the title "sound." Foundries making pressure-tight castings would be justified in restricting the interpretation to "freedom from unsoundness," but in other cases where general surface appearance is the main factor, the word would certainly be extended to embrace other properties. This state of affairs exists in all languages, and the French word *bochage* can be translated as any heavy scrap; heavy hematite ingot mould scrap and metal which has been pigged to ensure regularity of composition. Thus definition without reference to the full context is invariably unsatisfactory. Sometimes departure is made from a standard technical term to indicate a special phase. For instance, Mr. E. Longden uses the word "sullage" for slag when presumably it has become contaminated by contact with the apparatus connected with pouring operations. The use of such words undoubtedly enriches the technical vocabulary of the industry.

Correspondence

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Ancient Chinese Castings

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—Mr. A. Allison's letter of February 5, commenting on your leading article in your issue of February 3, is interesting and even entertaining. I take it that he means that the Transactions of the American Institute of Mining and Metallurgical Engineers are not easily accessible. They are quite accessible in America, as are most of the other references in the bibliography of the article to which you referred.

If Mr. Allison had seen my various articles he would be aware that, from the first, I have maintained that there is no evidence that the Chinese either learned the iron art from anybody else, or that they transmitted what they learned to anyone else. Their closest relations with another culture were with India, and it is quite certain that the Indian artisans did not learn from the Chinese how to cast iron, nor did the Chinese learn from India how to make steel by the Indian method.

Marco Polo did not make any references to iron castings. Neither did he to tea, fishing with cormorants, printing books, binding women's feet, and other things which existed in China at the time of his visit but were unknown in Europe. He somewhere says that he did not mention many things he saw because people would simply disbelieve him. That Marco Polo would have recognised that castings he saw were made of iron seems improbable. They were so old in China that no one would comment on them, and Polo never showed what might be described as scientific curiosity. But since we have the current instance of R. P. Hommel spending eight years in China gathering material for his book "China at Work," and yet never mentioning the Chinese type of windmill, one of the most striking things to be seen there, Polo's failure to mention anything is certainly valueless as evidence that it did not exist at the time

Mr. Allison's reference to looting and the suggestion that Chinese castings (mine?) may eventually be on exhibition at the Stahlhaus at Düsseldorf are cryptic in their implications. But it is certainly doubtful whether archæological work in China by other than Japanese workers will be possible from now on.

Your own references to my work are kind and complimentary. With the supposition that China had "a heavy engineering industry when the rest of the world was in the bronze age" being merely a "fanciful idea" I am in complete agreement. The first bronzes appear in China about the 14th century B.C., which is quite late for bronze. If you had said that China was making extensive commercial use of iron in the cast form when its use in the rest of the world was limited to cutting tools, that would be a statement of apparent fact. That the "flying scissors" were used for anchoring machinery is only one of many fanciful suggestions as to their purpose, none of which seems to deserve serious consideration.

But I cannot concur with your inference that the suite of specimens shows that "from the point of view of a good engineering cast iron . . . there was a steady deterioration through the years covered." I do not think it fair to speak of "engineering cast iron" in talking about the Chinese art. They used it for abrasion resistance in plough shares, heat resistance in cooking equipment, and as a metal cheaper than bronze which would mould well, but the idea of seeking for engineering strength was quite alien to them. The high combined carbon in the pagoda panels undoubtedly resulted from making the castings in metal moulds, while the presence of tin, tungsten and silver in that specimen is certainly peculiar. I can offer no explanation for the high combined carbon in the 20-ft. high built-up casting, and one wonders whether a small sample taken from an inconspicuous portion of so large an object is really representative of the whole thing. The samples are so few, cover so long a period of time, and so wide a geographical range, that I hesitate to come to any definite conclusions beyond that the Chinese were making good iron castings at least a thousand years before they were commonly made in Europe. I am sending you (under another cover) another Paper which presents the evidence that they were making iron castings a thousand years earlier than my earliest specimen.—Yours, etc.,

THOMAS T. READ.

Columbia University, N.Y.

March 1, 1938.

Midland Coke Research Committee

The most notable feature of the Report of the Midland Coke Research Committee for the year 1937 is the list of published Papers, seven in number, of which at least three deal with the standardisation tests, namely, the determination of the swelling power of coal, the determination of the real specific gravity and the critical air blast (C.A.B.) of coke. These Papers amplify the bare statements of progress in the annual report, and all who have referred to the Papers will know how thorough is the work on which the standardisation is based. Perhaps this is the best indication of service which a central research organisation can render to industry, where the time, opportunity, or even inclination to investigate a method of testing rarely arises.

The brief statement of progress made in this report will, no doubt, be amplified in the form of publications in the future, further information being available at the moment only to contributing members of the Committee. Much of the work is obviously of special local interest to the makers of coke in the Midland area and the users of that coke. Among the programmes of more general interest is the work on the classification of coal, on which enlightenment would be generally welcomed; a fundamental study of the carbonisation process; and the work on the resistance of beds of coke and of individual pieces of coke to the passage of air. Work on the use of coke for domestic purposes includes a study of alkali activation and of vertical retort coke which shows that the Committee has a fairly broad basis for its activities.

Notes from the Branches

Middlesbrough Branch.—The annual general meeting of the Middlesbrough Branch of the Institute of British Foundrymen was held on March 11, when the following officers were elected for 1938-39:—

Branch-President.—Mr. R. Miles (managing director, Head, Wrightson & Company, Limited, Teesdale Iron Works, Thornaby-on-Tees).

Senior Vice-President.—Mr. D. K. Barclay.

Junior Vice-President.—Mr. D. R. Kinnell.

Members of Branch Council.—Mr. J. Blakiston, Mr. J. G. Gould, Mr. H. Foster, Mr. W. Pierson, Mr. J. Ramsey, Mr. W. Siddle, Mr. G. O. Stanley, Mr. O. G. Wilson and Mr. S. S. Wrightson.

Honorary Secretary and Treasurer.—Mr. G. P. Kirk (The North Eastern Iron Refining Company, Limited, Stillington, Stockton-on-Tees).

After the meeting there was a demonstration of the latest foundry sand testing equipment organised by Mr. N. D. Ridsdale.

Random Shots

Those who annually delight in annual conferences must be watching affairs in Central Europe with considerable anxiety, wondering how the present unrest is going to affect the meeting in Poland this autumn. In Warsaw they have a little way of casting furtive glances at the statue of Sigismund when affairs are not going well, and all is well so long as the sword in his hand does not move. Should it be seen to move then they tremble, for it is a sure sign that real danger threatens their country. Now "Marksman" would appreciate a quiet and profitable way of spending the hot days of August, and offers his services as official observer beneath the shadow of Sigismund. Not being a devotee of vodka, there would be no danger of seeing with an unsteady eye.

* * *

Many people in London refuse to live in the flats which are being built for them under the slum clearance schemes, on the grounds that there are too many restrictions. One can readily sympathise with this attitude when it is realised that one rule for the ingoing tenants of a recently-erected block of flats is that not more than two birds may be kept in any one flat!

* * *

At the Qualcast staff dinner last Saturday, Mrs. Amatt, more familiarly known as Peggy, was amongst those awarded a gold watch for 20 years' service. This is not by any means the whole story in her case, for her parents and even her grandparents were in the service of Mr. Jobson's family! Mrs. Amatt is on the canteen staff and although it is unlikely that the firm have statistics to prove to what extent their success is due to Peggy, yet she must have the deeper satisfaction of seeing around her contented human figures which speak roundly of the results of her culinary control, and be happy in the comfortable knowledge that a man cannot do good work unless he is well fed.

* * *

Incidentally, a well-known firm has invented an entirely new flexible joint. It is to be hoped that they can introduce it to the seaside boarding houses in time for the summer trade.

* * *

In these days when there are machines for doing almost everything, when even the office is fitted with a dictaphone and a comptometer, it is surprising to find that so far no office has yet installed one of those natty wire-"pulling" mills. One will shortly be put into operation in a rolling shop in Russia which is capable of producing 270,000 tons of wire yearly. Think how useful this would be at directors' meetings and when negotiating Big Business.

* * *

Mention of wire is reminiscent of a private joke of little Tommy who thinks fit to giggle every time he passes a brassplate on a certain door in Sheffield which reads: "Amalgamated Society of Wire-Drawers"!

* * *

This little boy evidently finds words with two meanings a source of great amusement. He always asks his father to drive home on a certain road because it has a notice reading: "Danger, Bear Right Ahead." He never can find that bear!

* * *

And mention of little Tommy is reminiscent of the story of a note sent by mother to the school teacher. "I am sorry Tommy won't be fit to come back to school for some days. He hasn't even been to the pictures yet."

"MARKSMAN."

Corrosion-Resisting Cast Iron—Its Production and Use*

By FRANK HUDSON (Bureau of Information on Nickel)

There are three main types of corrosion-resisting alloys of iron available to-day suitable for production by foundry methods. The first and oldest of these is, of course, high-silicon cast iron, normally containing around 15 per cent. silicon, and known by a variety of trade names, such as Ironac, Tantiron, Duriron, Durichlor, Antaciron, Corrosiron, Fomiac Si, Acidur, Antiacid, Duracid, Elianite, Métillure, Thermisilid, Neutraleisen and Fersilite. Such material has been used since 1903 for acid-handling equipment of all kinds, but it suffers from several serious production disadvantages inasmuch as it is unmachinable and extremely brittle.

Around 1927 the high-nickel austenitic type of corrosion-resisting cast iron was introduced under the name of Nimol, now better known as Ni-Resist. This group has been recently extended to embrace other trade names, such as Nicrosilal, Causul, Hypercrode, No. 7 and N.33 alloys, Audcoloy, etc. All these latter alloys have much superior physical properties over the high-silicon cast irons previously mentioned and are readily machinable, with the result that their development has been rapid and they are being increasingly adopted for service in many branches of industry. The third and most recent advance is the advent of high-chromium irons, containing from 20 to 35 per cent. chromium, and whilst such material is still more or less in the experimental stage it has already shown promise of future importance.

Apart from the above there are as yet no other cast irons which can be classed as corrosion-resisting alloys in the full meaning of the term, although minor alterations in treatment, or composition, can in isolated cases improve its resistance to certain service conditions. Accordingly, in this present Paper it is not proposed to discuss the corrosion-resisting properties of modern high-strength irons such as Meehanite, Ni-Tensyl, etc., or the effect of low alloy additions.

HIGH-SILICON CAST IRON

In the early days when ferro-silicon was first introduced, attempts made to analyse it by the usual methods indicated that it was more or less insoluble in all acids except hydrofluoric. Accordingly, it was only natural that in due course a modification of this material should be put forward for the construction of acid-handling equipment and industry is indebted to Jouve[1] for possibly the first suggestion of this idea, when he presented a Paper to the Iron and Steel Institute in 1908 covering investigations conducted in France over a period of five years on "The Influence of Silicon on the Physical and Chemical Properties of Iron."

Due to manufacturing difficulties the early use of high-silicon iron was confined to small castings, and large-scale acid-handling equipment did not become available in this country and in the United States until about 1912. According to Tungay[2] valuable early development work was done by Jouve in France; Rossi in Italy; and by Lennox, Pearce and Marsden in Great Britain. During the Great War this material was employed extensively in the construction of plant for the production of explosives and succeeded earthenware and pottery, as formerly used for the condensation of nitric acid, in view of the speed with which it could be manufactured and the increased efficiency brought about by its use. For example, due to its greater heat conductivity, a condenser built of high-silicon cast iron handled a charge of nitric acid in 16 against 36 hrs. when pottery was employed as the material of construction.

Composition and Physical Properties

As the amount of silicon is increased in cast iron the physical and chemical properties vary considerably. Satisfactory resistance to acid attack is not obtained until the silicon content approaches 13 per cent., and at 19 per cent. and upwards the corrosion-resisting properties again fall. Tests conducted by Kowalke in America indicate that the silicon content for maximum resistance against sulphuric, nitric and hydrochloric acid at 10 per cent. concentration is as follows:—10 per cent. sulphuric, 14.8 to 17.3 per cent. silicon; 10 per cent. nitric, 16.1 per cent. silicon; and 10 per cent. hydrochloric, 18.5 per cent. silicon.

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3 Longden, J.: "Some Casting Problems of Acid-resisting Iron." Proc. Inst. Brit. Foundrymen, Vol. XVI, 1922–23, pp. 677–693.

4 Espenhahn: "Die Giesserei," No. 37, 1928. See FOUNDRY TRADE JOURNAL, March 7, 1929, p. 186.

5 See "Alloys of Iron and Silicon" (Monograph Series), by Greiner, Marsh and Bradley Stoughton. McGraw-Hill. Fig. 61, p. 138.

6 Matignon, C.: "Metals Resistant to Acids." Chim. et Ind., Vol. 2, 1919, pp. 1283–1302.

In practice the composition employed should accordingly come within the following limits:—Silicon, 13.0 to 18.0 per cent.; carbon, 0.2 to 1.0 per cent.; phosphorus, 0.2 per cent. max.; manganese, 0.25 to 2.0 per cent., and sulphur, 0.05 per cent. max.

Within this range of composition the following approximate physical properties are obtained:—Density, 6.8; tensile strength, 6.0 to 7.0 tons per sq. in.; compression, 34.0 tons per sq. in.; Brinell hardness, 450 to 500; melting point, 1,200 deg. C., and contraction, 0.25 in. per ft.

It will be observed that the strength of this material is low, and it is now appreciated that the form and amount of carbon present play an important part in this direction. The addition of 13.0 to 18.0 per cent. silicon reduces the solubility of carbon in iron down to around 1.75 and 0.80 per cent. respectively at the point of solidification, although much greater quantities than this can be held in solution whilst the iron is molten, depending on temperature and melting conditions. Furthermore, in view of the well-known graphitising action of silicon, all of the carbon present ultimately exists in the graphitic form.

Accordingly, it will be appreciated that if care is not taken in the selection of proper raw materials, in melting and in pouring, serious trouble is likely to arise, as pointed out by J. Longden,[3] through the evolution of free graphite or "kish" in the mould in conjunction with the presence of graphite in flake form in the iron, which further embrittles an already weak material. Investigations conducted by Schüz[4] in Germany in this respect indicate the favourable influence of a eutectic graphite form in maintaining strength.

In these experiments raw materials and melting conditions were selected so that the eutectic carbon content was obtained in the 16.0 to 17.0 per cent. silicon alloy (about 0.3 per cent. carbon). It was found that the formation of the compound Fe_2Si_2 takes place at about 1,045 deg. C. in the solidified alloy, and the separation of the graphite from the carbide occurs between 1,100 and 1,000 deg. C. The coincidence of the two changes seems to cause an especially favourable distribution of the graphite and the formation of small particles of Fe_2Si_2. In all cases where graphite flakes were formed segregation of Fe_2Si_2 occurred and lowered the strength because of their brittle nature. To obtain the best results the eutectoid[5] state should be aimed at in all the alloys, and this will embrace a carbon content of from about 0.6 per cent. for 13 per cent. silicon down to possibly 0.25 per cent. for the 18 per cent. alloy.

In view of the hardness of the high-silicon irons machining cannot be conducted, and castings must be finished by grinding. As a general rule any material in this class which can be machined with a cutting tool is unsatisfactory for severe corrosive work.

The high shrinkage of these alloys is also a troublesome factor in the foundry, and recent investigations disclose that this property is partially related to the state of the carbon. It has been suggested that the more carbon separated as graphite the greater is the total shrinkage, which fact stands out in contrast to the behaviour of grey iron. Taking everything into consideration, it would seem that the higher the purity of the iron-silicon alloy, the less is the potential danger of trouble.

Additions of other metals are not usually made to high-silicon irons, but Matignon[6] has reported that an alloy containing 2 per cent. nickel (Elianite II) is somewhat more resistant to corrosion than other alloys of similar composition except for nickel content.

Production Methods

High-silicon iron may be melted in the cupola, reverberatory, rotary, crucible or electric furnace (arc or high-frequency). Of these, the cupola must be considered the least advantageous in view of the difficulty in keeping the carbon content within the prescribed limits.

The basis of the furnace charge can be either hematite pig or steel scrap with, of course, ferro-silicon, and in the majority of cases, two meltings are necessary, the first to produce pig of the approximate analysis, followed by an adjusted remelt for the final castings. A direct melt, without the necessity for pigging, can, however, be satisfactorily obtained by melting steel scrap in an oil-fired reverberatory furnace. Espenhahn found that the most suitable starting mixture was as follows:—Pig-iron (4 per cent. manganese), 88 lbs.; steel scrap (0.6 per cent. carbon), 1,188 lbs., and ferro-silicon (80 per cent.), 374 lbs. This mixture gave good results in the foundry, and a final analysis of 16.0 to 17.0 per cent. silicon and 0.6 per cent. carbon. Care must be taken not to overheat during melting, and excessive oxidation can be prevented by the use of a suitable slag covering.

The pouring temperature of silicon iron should not greatly exceed the melting temperature, but this will, of course, depend to a large extent upon the size and section of the casting being produced. It is also advisable to cast as rapidly as possible. Liquid shrinkage is limited in extent and large feeding heads are not required.

Very real difficulties are presented to the foundryman by the high solid shrinkage exhibited by this material in conjunction with its low strength. Moulds must be very loosely rammed and cores made friable, and satisfactory measures must be taken after casting to "ease" any parts of mould and cores likely to restrict free contraction. Furthermore, every care must be taken to ensure the absence of fins which are also likely to accentuate cracking. For many castings the use of oil sand suitably protected by a refractory dressing has been found to be par-

* A Paper read before the Middlesbrough Branch of the Institute of British Foundrymen, Mr. J. K. Smithson presiding.

ticularly suitable. Chaplets should, of course, be avoided as far as possible, and if they have to be used they must be made from the same material as the casting. In Germany some manufacturers arrange that after pouring the castings should be placed in a furnace to be gradually cooled down.

More fundamental than any of the above points is the fact that all castings must be designed from the very beginning with careful regard to the properties of the material. Sharp angles should be avoided and sudden changes in section replaced by generous fillets. Vessels such as boiling pans, receivers, stills, etc., should be made with a curved bottom as large flat surfaces present contraction difficulties. All joints in pipe work must be formed by means of flanges, or spigot and socket, since the metal is too hard to screw or thread. Fig. 1 illustrates typical

[Courtesy, Haughton's Metallic Company, Limited.

Fig. 1.—Castings in High-Silicon Iron.

examples of correctly designed silicon-iron castings, and for further information on this matter reference should be made to J. Longden's Paper previously mentioned.

Welding operations can be conducted on this material, but success is difficult to obtain in view of cracking difficulties caused again by the inherent properties of the alloy, although it is of interest to note that the Duriron Company in America have developed a successful technique in this direction.

Application

Properly-made high-silicon iron castings have excellent resistance to attack by both hot and cold sulphuric and nitric acids either as single

Table I.—*Resistance of Ironac in 25 per cent. Sulphuric Acid at 100 deg. C.*

Material.	Loss in grammes per sq. metre per 24 hours.
Ironac	5.15
Austenitic cast iron ..	186.20
Grey iron	6,613.00

or mixed solutions. They are not considered suitable for handling hot concentrated hydrochloric, although the resistance to weak hot solutions and cold concentrated solutions is fairly satisfactory. Failure has also been experienced handling fuming sulphuric acid as silicon is readily oxidised by sulphur-trioxide (SO_3). Tests

(*Continued in next column.*)

(*Continued from previous column.*)

conducted by the author on the resistance of Ironac in comparison with austenitic and ordinary grey iron in hot 25 per cent. sulphuric acid are shown in Table I.

As well as being acid-resisting, these irons can be used against other corroding media, and for further information on this subject one should refer to the extensive data available elsewhere.[5] They have also been utilised for erosion as well as for corrosion-resisting purposes, such as, for example, pipes for handling wet sand.

The chief products made of high-silicon iron are: acid pans, cascade basins, stills, retorts, autoclaves, separator and condenser parts, bleachers, denitrating towers, pumps, stopcocks, valves, pipes and fittings, etc. The material cannot be recommended for vessels which have to be worked at internal pressures higher than 50 lbs. per sq. in., and it is also unsatisfactory for standing up to rapid fluctuations in temperature. The danger of cracking may be minimised by providing suitable facilities for expansion, but for pumps and valves high-silicon iron should not be used if the temperature change exceeds 40 deg. C. (100 deg. Fah.). In the case of large tower sections subject to appreciable temperature change the height must not exceed more than 1½ times the diameter.

(To be concluded.)

Income-Tax Assessment Procedure

SOME RECENT CHANGES

With a new year of assessment now current (April 6 to April 5) it seems useful to give a few hints concerning assessment procedure, as the new forms of return of income will shortly be sent out. This article will only give a broad outline of the commoner matters, the object being to give in more detail the changes, both legislative and administrative, which have recently occurred.

Assessment Procedure

Broadly, all business profits are assessable and all business expenses allowable. Private expenses are not deductible, meaning such items as drawings, family maintenance expenses; dwelling-house rent, rates and expenses; and so forth. If, however, part of a dwelling house is used for business purposes, an amount proportionate to the part so used (up to two-thirds) may be deducted for rent, annual value, rates, lighting, etc. On the other hand, what might be termed private profits need not be returned, that is, anything which is of an isolated nature and non-recurring would come under this rule, good examples being the sale of a house, of a business, of goodwill, of investments, and so forth. Premiums on leases and ordinary Stock Exchange transactions are also usually outside tax assessment.

The current forms will apply for profits made in year ending April 5, 1938, and this ordinarily applies for both Schedule D (business profits; persons on own account) and Schedule E (employments: directorships come under this schedule), although for firms under Schedule D an earlier year-ending date can be substituted, according to the ending date of the accounting year of the particular firm concerned (*e.g.*, December 31, 1937).

Changes

Rent and annual value of business premises are deductible, and in connection with annual value the following points should be noted, as there have been recent changes. The amount allowable ordinarily is not the gross value, but the value after the statutory allowances for repairs (Income Tax law) have been deducted, although for certain premises (*e.g.*, factories) gross value has been allowed. Now, ordinarily the allowance will be the gross value less the statutory repairs allowance (Schedule A assessment) for ordinary concerns. But for factories, mills and similar premises (broadly meaning premises where machinery is used) the foregoing amount will be allowable, and in addition a further amount given, which may be either an amount equal to the Income Tax statutory allowances for repairs or, if the amount is less, one-fifth of the rateable value (for premises in London and Scotland one-sixth). Rateable value, of course, means an assessment made for local authority rates, which is not necessarily the same as that scheduled for income tax purposes. The statutory allowances for repairs under income tax procedure are as follow (the period of application of these rates has been recently extended to apply until April 5, 1942).

The allowances are given off gross value: for premises up to £40, one-fourth; for values of £40 and up to £50, a sum of £10; for values of £50 up to £100, one-fifth; and for over £100, £20 plus one-sixth of any excess over £100. For lands, one-fourth of gross value applies.

This additional deduction applies to a lessee of premises if he is responsible for the whole of the repairs, as well as to occupiers carrying on the trade who are the owners.

Discount is payable off Schedule D tax payments if made before the date when due, the rate being 2½ per cent. per annum, and the deduction being proportionate to the period between the date of prepayment and the statutory date of payment (*e.g.*, January 1 or July 1). Formerly, only this discount could be obtained if claimed at the date of payment, but recent law now allows such discount to be claimed as a repayment, if written application is made within one month of prepayment.

Reminding Points

Amounts for depreciation which go through ordinary accounts are, of course, not allowed for tax purposes, but allowances for machinery and plant are given under the wear and tear rule by yearly percentage allowances on written-down value each year, and should be always claimed (in a special space on the form), even though not required for any reason in any year (*e.g.*, small profits), as these can be carried forward indefinitely to any subsequent year. Wear and tear allowances operate after profits have been declared on the form. A wide interpretation is given to the term "machinery and plant," and fittings and fixtures and motor vehicles are included in the term.

Furthermore, under the obsolescence rule an amount is deductible for machinery and plant introduced to replace obsolete machinery and plant. This is deductible as a trading expense, being the amount of the cost of the new machinery and plant, less any wear and tear percentages taken. The figures representing the cost of the new machinery and plant are then substituted for the old figures in the wear and tear list, and future wear and tear allowances are then based on these figures.

The cost of renewals of utensils, etc., can be deducted as a trading expense. Usually this renewal rule operates for the smaller articles, the wear and tear percentage rule being used for the larger items of machinery and plant.

C. Akrill & Company, Limited

Mr. Theodore D. Neal, who presided at the annual meeting of C. Akrill & Company, Limited, in Birmingham last week, said the directors recommended a dividend of 2s. per share and a bonus of 1s. per share, both free of tax. The satisfactory results of the year's trading were due largely to the activity in the iron and steel trade, on which the company depended for its business. The turnover had materially increased and the rate of profit was well maintained. Future prospects looked good.

Equipping of a Fettling Shop*

By JOHN CAMERON, Junior

Before setting out to discuss the various means of converting the product of the moulding shop into a saleable article, it would be of interest perhaps to follow the various steps which led to the complete re-equipment of a fettling shop dealing with almost all varieties of light castings. These castings include rainwater pipes and gutters; soil, drain and underground water pipes and their attendant connections; various small castings for the general engineering trade, and finally castings for marine-valve gear up to four tons in weight. The last two classes of casting are supplied both in what is called "ordinary" cast iron and Meehanite high-duty cast iron.

Before the lean years of 1930 to 1934, the fettling shop of Cameron and Roberton dealt with a daily output of approximately 32 tons of castings. This total consisted, to a very large extent, of heavy drain and water pipes; these pipes are easily and quickly cleaned of sand, while any fettling takes the form of smoothing down the face of the runner and little else, a very simple job requiring no plant whatever; second, came the pipe connections, and lastly the jobbing castings. Only the last two categories require any proper fettling.

During the depression, naturally, there was no difficulty in dealing with the volume of work on hand, but all this time the company had been developing a very extensive trade in drain-pipe connections and special castings, and in 1933 were added the special Meehanite castings. As the trade in pipes had declined, the tonnage output appeared low, but actually the shop was fully engaged, due to the more complex work being handled.

When business began to pick up again in 1934, the management suddenly realised that there was a very acute bottle-neck in the fettling shop, and although the moulding shops were delivering about 140 tons of castings per week to be fettled, it was only by working considerable overtime that the resulting fettled castings could be handed over to the despatch department in the same period, and this in spite of the fact that there was a cast on only five days per week.

This state of affairs was almost entirely due to the increased quantities of connections of the type shown in Fig. 1, so, as there were no signs of a reversion to the earlier preponderance of heavy pipes, actually the contrary being the case, the management proceeded to re-equip the shop to tackle economically the new types of castings being produced.

Any fettling shop can be split into two well-divided sections:—(1) That dealing with cleaning the casting and (2) that dealing with the removal of fins, flashes, gates, runners, etc., and it is proposed to deal with them in that order.

Rumb'ers

Among foundries producing castings for the building trade, the commonest method of cleaning castings is by rumbling, or revolving the castings in a drum-shaped receptacle, in close contact with hard iron stars of a suitable size. Rumblers vary considerably in design, the two most popular being that with a hollow trunnion for dust-exhaust purposes, and that where the trunnions are solid, and dust exhaust takes place from an enclosing hood.

The advantages of rumbling are that it produces an adequate finish on most classes of casting, the plant is relatively cheap, and power and maintenance costs are low, with the result that cleaning costs per ton are low. The disadvantages of rumbling are that, broadly speaking, it cannot produce a finish sufficiently good for enamelling in a sufficiently short space of time. Secondly, it is an extremely noisy process, so much so that it is always advisable to have the rumblers in a separate shop from the fettlers. Thirdly, there is always present the possibility of broken castings.

Elaborating on these last two points, where the rumblers can be installed in a shop by themselves, the hollow trunnion type is generally used, but where they must be in the fettling shop proper, the solid trunnion type enclosed in a wooden or sheet metal hood is advisable, due to the fact that this enclosing hood silences the noise to a very considerable extent. As regards broken castings, this is almost entirely due to the skill of the rumbler loader; a good man will rarely lose a single casting, but cases are known where an inexperienced man has broken 50 per cent. of the rumbler's load.

The time necessary to clean the castings depends entirely on the finish required. From twenty minutes to half an hour should remove all loose sand, and from 45 minutes to an hour and a half should produce a good smooth skin, though castings which have to be painted without further cleaning are often rumbled for two hours.

Shot-Blasting

Where a satisfactory finish cannot be obtained by rumbling, sand-blasting or shot-blasting is the most common method of securing a clean finish. There are three distinct types of sand-blast installations: (1) the rotary-table type for flat castings such as are used in the fitted goods trade; (2) the combination tumbling barrel and blast jet type, sometimes called the "tumblast," generally used on small engineering castings, and (3) the larger cabinet sets employing either externally or internally operated nozzles, and suitable for cleaning castings too large to be handled by either of the two former methods.

As an abrasive, sand has been almost entirely superseded in recent years by chilled iron shot, due to the much more efficient cleaning with shot, and also to the risk of the operator contracting silicosis when using sand.

Shot-blasting or sand-blasting is, however, a fairly expensive process, but it is the most widely used method of securing a finish sufficiently clean for enamelling. It is also necessary for cleaning castings such as motor cylinder blocks, which will subsequently be in close contact with lubricating fluids. The principal disadvantage of shot-blasting is the large amount of horse-power required to maintain the required pressure of air at the nozzle or nozzles, and the heavy maintenance charges. The figures for power are so well known that there is no point in repeating them here, but the cost of compressed air may be taken to be between 1¾d. and 3d. per thousand cub. ft., depending both on the size of the installation and the pressure employed. A representative figure for total cleaning cost, that is inclusive of power, maintenance, abrasives, labour and depreciation, may be taken as between 8s. and 9s. per ton.

Shot-Slinging Machines

The most recent development in the cleaning field is that type of machine using centrifugal force to impart to the abrasive the energy necessary for removing the sand or scale. In this class both the Wheelabrator and the Sand Wizard are widely advertised, the difference between the two makes being in the design of the impeller head; in one case it is rather like the impeller of a centrifugal pump, and in the other case has two blades and resembles the sandslinger.

Originally, the Wheelabrator type of machine was only available in the tumblast style, but now both this and the rotary table styles are on the market. So far, the system does not seem to have been applied to cabinet sets, and it is doubtful if it will be possible to adapt it for this purpose, but the author would be the last person to say that it was impossible. It is clear, therefore, that up to the present, centrifugal cleaning can only be applied to small castings, but there appears to be no doubt that the finish produced is excellent and quite as good as that obtained by shot-blasting.

The outstanding advantages of this type of machine are the relatively low power and maintenance costs when compared to compressed-air installations, and most foundrymen will have seen a recent advertisement which claims a cleaning cost of 28.374d. per ton. When depreciation has been added to this figure, the full cost would appear to be around 3s. 6d. per ton based on an 8-hour day, or 2s. 10d. per ton taking advantage of working a 23-hour day. When this figure is compared with the cleaning cost by the compressed-air method, there is little wonder that these machines have developed so rapidly.

Hydraulic Cleaning

A further cleaning method which has received a little publicity recently is the "Hydroblast" system. Here, a jet of high-pressure water is directed on to the casting to be cleaned, and, due to the sand mixing with the water, an action comparable to sand-blasting is set up, the difference being that the water carries the abrasive and there is a complete absence of dust. This system appears only to have been applied in the United States, and originally was restricted to heavy castings, but members will recollect that Dr. A. B. Everest stated in his recent Paper on American developments that this type of cleaning had also been applied to small engineering castings. It would appear on the face of things that where there is ample room available and an abundance of water, this method merits very considerable attention for medium-sized and large engineering castings.

Of the various methods, briefly dealt with above, available to-day for cleaning castings, rumbling was chosen for the new shop because (1) it is the cheapest; (2) a sand-blast finish is not required on the majority of the castings produced, and (3) the water system was not considered.

Four rumblers, two of which are shown in Fig. 2, were installed, of the solid trunnion type with built-in dust hoods, as they had to run in the same shop as the dressers. Two are 7 ft. long and 31 in. across the flats, and ten-sided; one is 4 ft. long and 25 in. across the flats and hexagonal, and the fourth—a small one—is 3 ft. long and 24 in. across the flats, and octagonal.

The two larger rumblers are driven by a 9-h.p. motor, and the two small ones by a 5-h.p. motor. In the large rumblers, soil-pipe and drain-pipe connections are cleaned, the two classes being kept separate as far as possible due to the risk of the lighter soil connections being damaged by the heavier drain pipes. It takes, on an average, half an hour to clean a batch of castings satisfactorily, and nine batches per rumbler are handled daily. The two smaller rumblers tackle various other types of castings, a complete load of the same type being put through at a time.

Pipes of all descriptions are not rumbled, but cleaned by hand. The heavy underground and drain pipes in 9 ft. and 6 ft. lengths are built up in a bank, sockets all the one way, and as the runner mark on the socket is chipped smooth, the pipes run along a pair of rails to the brushers, who clean them inside and out with wire brushes. A large brushing table deals with the dust question during this operation.

* Paper read before the Scottish Branch of the Institute of British Foundrymen.

Heavy and bulky drain connections, too large to rumble, are also cleaned by hand, but on three brushing tables 8 ft. square, shown in Fig. 3. This cleaning down by hand is always the dirtiest and most objectionable part of the work in a fettling shop, and the provision of these tables has made a most remarkable improvement in the atmosphere of the whole shop; it is always clear and healthy, and the walls and windows maintain their cleanliness for much longer periods.

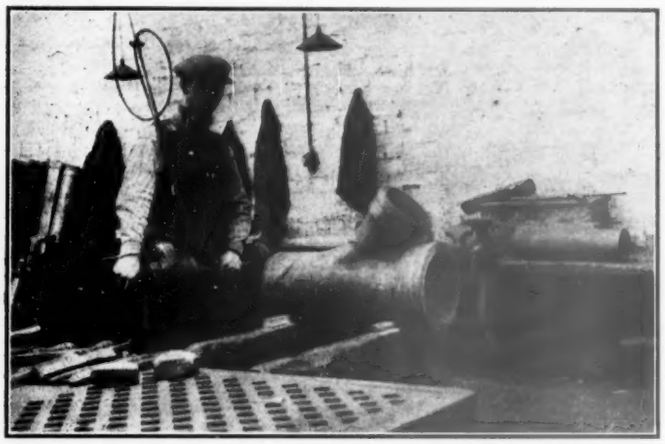

Fig. 1.—Type of Cast-Iron Pipe Connection, increasing demand for which led to a Fettling-Shop Reorganisation.

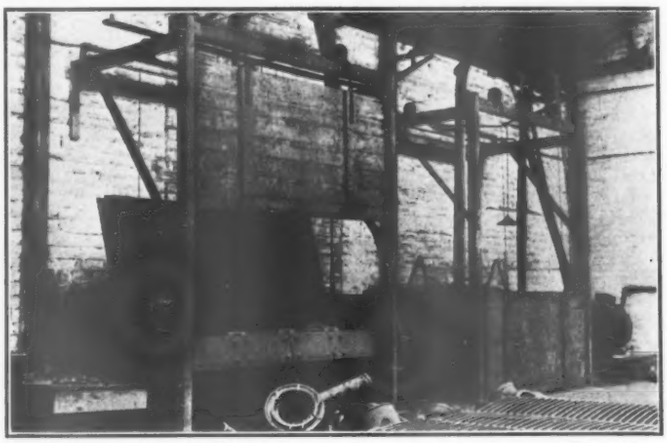

Fig. 2.—Two of the Solid-trunnion Rumblers with Built-in Dust Hoods.

Dust Extraction Plant

A dust extraction plant was installed at the same time. Dust is extracted in all from five brushing tables, four rumblers, and four double-ended floor grinders. The fan is of ample capacity, driven by a 21-h.p. motor, and capable of maintaining a negative pressure of 2 in. water gauge with the whole number of suction points in use and the dust collector sleeves clean. The collector itself is of the dry type, and consists of 48 canvas sleeves 12 in. dia. by 9 ft. 6 in. long. A small gauge is fitted to the fan staging, and when the negative pressure rises to 1 in. water gauge, the sleeves of the collector are shaken and cleaned.

Fig. 3.—The Brushing Tables on which Heavy and Bulky Castings are Hand-Cleaned.

The rumblers are completely enclosed by hoods made from ordinary tongued and grooved boarding. Care is taken to see that all joints are really tight so as to maintain a good suction. The journals are outside the hoods, out of the worst sand and dust, and are easily accessible for lubrication and other attention. As previously mentioned, these hoods act as excellent silencers for the rumblers when these are in motion. The brushing tables are very strongly built, the tops being half solid, half heavy grating; the sides and cleaning doors fit very closely, and the area open to suction is approximately 7 sq. ft. The floor grinders are fitted with special combined wheel guards and exhaust hoods; heavy matter falls directly to the bottom of the container, which has a large cleaning door, and dust exhaust takes place from about halfway up the hood. On one occasion when a very fine sand was required for moulding purposes, silt from the dust collector was proposed as a possibility. On analysis, however, this silt proved to be almost 75 per cent. metallic.

Fettling of Castings

Much work is still done by the hand hammer, chisel and file, and for intricate work it is difficult to see that they will ever be displaced. On medium-sized castings and heavy work, the pneumatic chisel has by now penetrated even into the most conservative shops, and probably there now exists no man who will maintain that he can beat a pneumatic chisel by hand. The pneumatic tool is also extremely useful when used with long chisel bars for digging cores out of larger castings.

Quite separate from this type of fettling appliance are the grinding machines. There must be very few shops where some types of casting cannot be quickly and neatly finished by this means. These machines are divided into two classes:—(1) Normal speed, operating at around 5,000 s.f.p.m., and (2) high speed, operating at around 9,000 s.f.p.m. The first class of machine uses vitrified bonded wheels, and the second class bakelite bonded wheels. Almost any combination of grit and hardness is obtainable in either type of wheel, generally a softer wheel being used on hard materials, and a harder wheel on soft and ordinary irons. The high-speed machines must be exceptionally strongly built, and are claimed to remove metal at twice the speed of normal-speed machines.

In this class of machines also enter the swing-frame grinders. These are generally suspended from their centre of gravity by a block and tackle, and are popular on medium-sized castings, as the wheel is brought to the job, not *vice-versa*. They are made both in normal-speed and high-speed types.

Yet another class of grinder is the small portable type operated either from compressed air or electrically. The compressed-air models are available working either on the turbine or the reciprocating principle; the turbine type would appear to have the advantage due to simplicity of working parts and the high spindle-speeds obtainable. Compressed-air grinders also have the advantage that, if accidentally stalled by an inexperienced operator, there is no armature to burn out. The electric grinders were for a long time handicapped by the difficulty of securing a sufficiently high spindle-speed. This has now been overcome to a considerable extent by the introduction of the high-cycle type of machine in which almost any speed may be attained; this machine is also less susceptible

Fig. 4.—Double-ended Floor Grinding Machines for dealing with Smaller Connections.

to armature trouble, and represents a great advance on the older type of machine. A wheel 6 in. by 1 in. seems to be one of the handiest sizes. These machines are useful in most shops for finishing operations, particularly on the inner surfaces of cylindrical castings. In the fettling shop already described almost all of these aids to manual labour are found in one form or other.

The smaller connections, after being rumbled, are passed to a set of three double-ended normal-speed floor grinders (Fig. 4). Two machines have 16 in. by 2 in. wheels and one has 18 in. by 2 in. wheels. The smaller castings are dealt with on the smaller wheels, leaving the larger machine to tackle the drain connections. These grinders are driven by 4-h.p. and 5-h.p. motors respectively, which are installed within their bases and completely closed in. The drive from the motor to the grinding spindle is by vee belt and is particularly good. This arrangement has the advantage of doing away entirely with overhead shafting and belting, giving the fettler complete freedom around his machine, and in the case of removal the complete unit may be lifted from the ground and set down again ready for operation with a minimum of disturbance.

Grinding Speeds and Work Tables

The spindle speed of the smaller units is 1,200 r.p.m., giving a grinding speed of 5,000 s.f.p.m. at 16 in. dia. The larger machine has a two-speed pulley, so that the spindle may be run either at 1,050 or 1,200 r.p.m.; the slower speed is used for a new wheel and it is stepped up to the higher speed when the wheel wears down below 16 in. dia. A fourth machine with 16 in. by 2 in. wheels handles small flat castings. The wheels, incidentally, are about 31 in. apart, giving comfortable room for two operators. The grinding wheels used are on the hard side—the result of much experimental work as regards grit and grade. Owing to the fact that most of the castings handled are made very accurately to pattern, there is no necessity for removing a large amount of metal; consequently, life is of more importance than free-cutting properties. The harder stone also maintains its shape better and requires dressing less frequently. For good fettling on such a grinder, too much stress cannot be laid on the necessity of having sturdy work-rests of ample size and capable of accurate adjustment. It has been personal experience that most work-rests are far too light and quite incapable of withstanding the very severe conditions found in most foundries. The method of attaching these rests to the body casting of the grinder is often also open to criticism.

Small Tools for Finishing

From these floor grinders, the castings are passed on to benches, where any finishing necessary is done by hand. The pneumatic chisel has been tried repeatedly for this work, but there is insufficient mass in the casting to offer reasonable resistance to the hammer. A considerable number of the heavier castings, which are cleaned on the square brushing tables, such as inspection pipes, are fettled by hand hammer and chisel and finished by a portable electric grinder using a 6 in. by 1 in. stone. This grinder is hung on a compensating spring, leaving the operator free to direct the stone without having to waste energy holding the weight of the machine. Two pneumatic grinders of the turbine type are also used continuously, both on this work and some of the jobbing castings.

The bulk of the jobbing castings are dealt with by a special squad using pneumatic chisels, hand tools, small pneumatic grinders and also a swing-frame high-speed grinder, depending on the size and shape of the casting in question. As in most other jobbing foundries, they are liable to get almost anything to fettle, from a coal cutter casing in Meehanite with a strength of 25 tons per sq. in., through feed-water heaters and marine slide valves, to small diesel-engine cylinder blocks, so naturally they require a pretty complete kit of tools.

Fettling Meehanite Castings

The high-duty Meehanite castings raised some very interesting points as regards fettling. The moulding practice with these castings is more akin to steelfoundry practice than iron, and, as a result, there are sometimes heavy risers to remove. Although these are considerably smaller and fewer in number than on a steel casting, they often are quite a problem. On small castings, these risers may sometimes be knocked off by a shrewd blow from a heavy hammer; this practice, however, is dangerous and may lead to a casting being spoiled due to the riser breaking in unless considerable care be exercised. Where it is inadvisable to use this method, the riser is cut round at the neck with either a pneumatic chisel or a metal saw to such a depth as to make breaking safe, while on the heavier castings, two or more holes are drilled in the neck instead of cutting.

Whatever method of removing the riser proper be used the casting is always left with the stub, which must be fettled flat; this frequently entails the removal of a considerable weight of metal and is an expensive business, so tests were carried out with hand chisel, pneumatic chisel, portable grinder and the swing-frame high-speed grinder to find out the most economical. The swing-frame grinder won in a canter from the pneumatic chisel (the other two being a long way behind), and has proved itself a most versatile instrument, being very well balanced and capable of working in any position. The wheel is 16 in. by 2 in., running at a speed of 9,000 s.f.p.m. The bond is bakelite, and the grit and grade are chosen to give the freest cutting possible combined with reasonable life. In this instance, rapid removal of metal is of prime importance, and on a series of heavy castings, stubs 4 in. square and $\frac{3}{8}$ in. thick were consistently ground flat in seven minutes; this represents a rate of removal of metal of over $\frac{1}{4}$ lb. per minute.

In conclusion the author would like to thank those members of the staff of Cameron & Roberton, Limited, who have assisted in the preparation of this Paper.

Book Reviews

Engineering Metallurgy. By Bradley Stoughton, Ph.B., B.S., and Allison Butts, A.B., B.S. Published by The McGraw-Hill Publishing Company, Limited, Aldwych House, London, W.C.2. Price 24s. net.

The third edition of this book has been revised and added to in order to bring it into line with the developments and progress which have taken place during recent years in the engineering and metallurgical industries. Chapters XVII and XVIII in the second edition have been omitted, but most of the material dealt with in these chapters has been retained after condensation by incorporation in Chapter V, which deals with chemical and electro-metallurgy. A new chapter on the application of metals in engineering has been added, and deals with automobile manufacture, railway rolling stock, machine design and static structures.

In revising the various other chapters, among the subjects which have been added or expanded are those of inspection and testing of materials, alloy steels, high-duty and alloy cast irons, aluminium alloys, oxygen-free copper, beryllium copper, silicon bronze, zinc-base die-casting alloys, the heat-treatment of non-ferrous alloys, the theory of alloys, flash roasting, the continuous distillation of zinc in vertical retorts, and the utilisation of metallurgy in design. Technical data have been brought up to date, and three brief appendices have been added, giving information for reference on the Society of Automotive Engineers (S.A.F.) Steel Specifications, the standard definitions for heat-treatment, and the names of the various recognised micro-constituents of steel. The references at the end of each chapter to periodicals and text-books have also been revised. In doing so, such references might have been enhanced considerably by the addition of references to original Papers in the cast of certain subjects.

The general character and utility of the book have been maintained, and the revision by curtailing the treatment of the chemical metallurgy of metals, and augmenting the properties and utilisation of the alloys available to the engineer, has added to its value as a text-book, not only for students but also for metallurgists and founders as well as for all designers and users of metals and alloys. As a brief and wide summary of the up-to-date principles of engineering metallurgy, the present edition of this book is to be welcomed, and can be recommended as such, and also as a useful basis for more advanced study.

J. W. D.

The Structure of Steel Simply Explained. By Eric N. Simons and Edwin Gregory, Ph.D. Published by Blackie & Son, Limited, 50, Old Bailey, London, E.C.4. Price 3s. 6d.

If one is convinced that it is desirable for people other than metallurgists to understand metallurgy, then this book has well fulfilled its object, which is clearly set out as "the whole story of steel and its structure told in words he (steel user, layman or worker) can understand, told simply and straightforwardly yet without inaccuracy or mis-statement."

It is divided into thirteen chapters which take the reader from "mixtures, compounds and solutions" to X-rays in quite logical fashion via the salt-solution diagram, and the usual route. Nothing could be simpler except, perhaps, the actual wording, for the authors, in search of simplicity, have become in places dramatically verbose. Such wording as: "Alas! He sees no structure at all (unless he has somehow got hold of one of the exceptions to the rule). He consults his tutor and learns that something more has to be done before the steel's structure becomes visible. Why is this?" could be reduced by more than half whilst actually gaining in simplicity of expression. If there be any fault with this book it is the over-doing of the "popular" aspect, and should a second edition be required—as can be confidently expected—more attention should be given to this point. We have nothing but praise for the assembly of factual information in the book.

Catalogues Received

Ring and Disc Filing Machine. A four-page leaflet received from Lorant & Company, Limited, 98-100, Croydon Road, London, S.E.20, contains a very interesting illustrated description of the Rindis ring and disc filing machine, which claims to eliminate or at least reduce to a minimum the operation of hand filing. The machine carries a 10-in. dia. filing disc and a ring with semi-circular milled teeth, both components being adapted to reconditioning. As speeds of filing need adjustment for the type of material operated upon, ample gearing has been incorporated in the machine for effecting this.

Bearings. The Phosphor Bronze Company, Limited, of 54, St. Thomas Street, London, S.E.1, have sent us an eight-page booklet which describes "Compo" oil-retaining bushes and bearings. The major use for such material appears to be in the direction of domestic appliances and those where neglect of lubrication can be confidently expected. Do moulding machines enter this class?

Non-Destructive Testing

METHODS AND THEIR LIMITATIONS

At a meeting of the Midland Metallurgical Societies, held on March 3, MR. J. P. REED read a Paper on "Non-Destructive Testing," in the course of which he reviewed the history of various methods, thereafter giving a description of the methods employed in the research department of Tube Investments, Limited. We append some extracts.

Primarily the author's experience concerns tubes, welded and weldless, and tubular materials, mainly steel and hence mainly magnetic. It should be remembered that the stainless 18-8 chrome-nickel steels are austenitic and therefore non-magnetic in the normally accepted sense of the term. In such tubular materials faults consisting of very thin elongated non-metallic inclusions may only constitute one hundred thousandth of the cross-sectional area of the tube, but could cause serious trouble in operations such as expanding. A roller expanding test would probably reveal the trouble, but one could not expand every half inch of tube made. A satisfactory non-destructive test would enable every portion of the tube to be examined in a routine manner. In order to assess the various methods of non-destructive testing, it was, of course, necessary to obtain material having defects of known character and depth.

Electrical Methods

The relationship between current and the magnetic flux produced by it is a property that has proved most useful to investigators of non-destructive testing methods. In a magnetic material any discontinuity or local physical change of structure may cause this phase relationship to change. If, therefore, one has sensitive instruments to detect the phase change, the only thing left is the precise interpretation of it.

From their nature, electrical methods would be expected to be capable of indicating deep-seated flaws as well as those on or near the furnace. Sperry in America developed a direct-current method for testing rails for transverse flaws, and a test car was fitted up for use on the railway system The scheme involved the use of three search brushes connected to a differentially-wound primary of a transformer. When equal currents flow in each half of the primary, no e.m.f. is produced and the secondary coil e.m.f. is zero. If a defect occurs, resulting in an increased resistance in one section, an e.m.f. is produced in the secondary coil which is amplified and operates a relay and an autographic recorder. It was found, when tried out in 1931 by the author's department, that owing to the difficulty of getting constant resistance values at the brush contacts the method was quite useless and all kinds of spurious changes were measured, varying continually over the same length of material. Sperry was satisfied because the defects in his rails were large compared with the tiny defects that they were seeking to locate in electrically-welded tubing.

If alternating current is used for energising a surrounding coil, circumferential eddy currents can be produced. A surrounding search coil will now detect changes in eddy currents, and, in fact, two search coils can be balanced against each other and any out-of-balance condition caused by non-uniformity detected by a suitable instrument. While there is a strong objection to stating firm opinions about the work of other investigators, the author believes the use of an a.c. magnetising coil for the detection of fine defects is open to three objections because inherent conditions tend to swamp or mask the real defects. In the first place, the material must be passed through the coil at an absolutely uniform rate. Secondly, any local change in permeability of the material affects the reading, and finally, in the case of tubes, any eccentricity affects the resistance paths of the eddy currents.

In conjunction with the British Thomson-Houston Company, Limited, an associated company has investigated the possibility of using an audio-frequency test in the examination of electrically-welded tubes. This consisted in supporting the tube at the centre of its length and inducing oscillations at audio frequencies by means of a steel ball dropped on to the tube from a definite height. It was found that, owing to the inaccuracy of human audibilities, the limits of error were much too great. A mechanical test of greater accuracy was therefore tried, by oscillating the tube torsionally by clamping one end of the tube to, and co-axially with, an alternator. The other end of the tube was loaded with such a mass that it would resonate at 50 cycles per sec. The alternator was then supplied with single-phase 50-cycle current and the motor energised with d.c. Oscillations were obtainable in the tube of such magnitude that the corresponding shear stress approached 19 tons per sq. in. The results, however, showed no correlation with weld strength, presumably on account of the relatively low stress imposed upon the weld itself, as distinct from the large shear stress in the wall of the tube.

Non-Metallic Inclusions

X-rays, including rays from radio-active materials, are useful for the inspection of parts likely to contain large cavities or inclusions of non-metallic material. They do not, however, enable thin fissures and filaments or laminæ of non-metallic matter to be detected with certainty below a limiting size for any given thickness of metal. The equipment to generate penetrative radiation necessitates high voltages; that is expensive X-ray tubes and transformer. The alternative is costly radio-active material and the lengthy exposures necessary dependent upon the thickness of the metal. Up to the present the application of X-rays for this purpose has been limited to the various ordnance factories and to some of the larger manufacturers of welded pressure vessels. It would be safe to say that for routine inspection of mass-produced material X-ray inspection is not likely to be either satisfactory or economic. There is the added difficulty that a thin lamina may lie edgewise to the X-ray beam and cast practically no shadow, although its dimensions at 90 deg. to that plane may make it a serious defect.

Apparatus Available

The Magnetic Analysis Corporation of America sell an apparatus depending for its action upon the magnetic properties of iron and steel. This apparatus is, it is believed, at present restricted to bars and tubes up to 4 in. dia. This is due to what is termed as the skin effect of an alternating-current, which tends to crowd the outer cross-sectional rings of a conductor. The effect is naturally a function of the particular frequency of the supply voltage. By placing a piece of iron or steel within a coil of wire certain magnetic effects are produced, mainly governed by the magnetic permeability and/or its physical soundness and dimensions. By taking two exactly similar pieces of iron or steel and placing them within two identical coils in series, the same magnetic effect would be produced in each. If, however, one of the pieces contained a flaw, or was dimensionally different, or had a different magnetic permeability for any reason, the magnetic effect would differ as a direct result. In practice an oscillograph is used to observe the wave form of the magnetic hysteresis occurring in the material under test. It is claimed that cracks or internal flaws interrupting the normal eddy currents in the material due to the magnetising coils, are seen by a change in wave form occurring in a standard piece. Alternatively the two magnetising coils are threaded on the test material and relative changes in that particular piece of material can be noted. The variations which will affect the ultimate wave form are:—Dimensional variations, changes in magnetic permeability due to slight changes in heat treatment or subsequent cold work, and physical unsoundness. The query that remains is the inevitable one as to how one can be sure of a standard bar unless it has been non-destructively tested by an already approved method, or thoroughly destructively tested in the old way, by which time there is no standard material left.

Limitation of Magnetic Tests

Methods utilising purely magnetic inspection are limited to defects of such a character that they give rise to distortion of a magnetic field set up in material. Transverse fissures or inclusions of sufficient size would give rise to leakage flux in their neighbourhood when magnetised longitudinally. Similarly longitudinal defects would give indications with transverse magnetisation. Thus with steady magnetisation a suspension of finely-divided iron or iron oxide in paraffin may be applied to the parts under test, when adherence of the particles will mark out surface cracks or defects. This method has been developed by various firms who supply apparatus suitable for such work. The method is an ideal one for the inspection of polished surfaces containing fine cracks normally invisible to the eye. That is not to say that rough, scaled or machined surfaces cannot be examined by this method, but more care is necessary and a little more skill may be required. Subcutaneous or internal defects may be detected in this way, but this depends upon the amount of magnetisation applied to the material and to the location and size of any faults existing. In all inspection by this method, the degree of magnetisation imparted to the steel is of great importance. If the steel is saturated with magnetic flux there will be a certain amount of external flux, and this may cause the actual defect to be masked. If, on the other hand, the degree of magnetisation is very low, the flux tending to be broken by an actual defect may revert to the remaining sound portion of the metal and fail to give the distorted external field. In this type of test either alternating or direct-current magnetisation may be applied. If the former is used, and material is reasonably retentive, the current need only be switched on for an instant, and the subsequent immersion in suspended particles of iron or magnetic iron oxide can be carried out, utilising only the permanent magnetism in the material. It is often necessary to demagnetise material tests, after direct-current magnetisation, by means of an alternating-current demagnetising coil.

Iron Powder for Detection of Faults

As recently as last July, Holtschmidt published a Paper in Germany dealing with the magnetic method, using iron powder for the detection of faults. He stated that in this method various anomalies had been observed, and in some cases crankshafts had been rejected because of definite indications that cracks or inclusions existed within the shafts, but micro-sections had proved that such cracks did not exist. He showed that similar indications to those given by genuine flaws, such as cracks, inclusions, etc., can be produced on steel after cold deformation with a pencil of ferromagnetic material, provided that during the cold working and in the magnetic testing the surface of the steel is under elastic stress, or that the test-piece was magnetised prior

(*Concluded on page* 266.)

British Iron and Steel Federation

ANNUAL DINNER IN LONDON

The annual dinner of the British Iron and Steel Federation was held last Thursday at Grosvenor House, Park Lane, when about 1,400 members and guests were present. The Right Hon. the Viscount Greenwood, P.C. (President), was in the chair, the chief guest being the Right Hon. W. S. Morrison, M.C., K.C. (Minister of Agriculture and Fisheries). Others included the Right Hon. the Earl of Dudley, M.C.; Col. Sir W. Charles Wright, Bt., K.B.E., C.B.; Lord May, K.B.E. (Chairman, Import Duties Advisory Committee); Col. J. B. Neilson, C.M.G., D.S.O.; Engr. Vice-Admiral Sir Harold A. Brown, K.C.B.; Sir Arthur Robinson, G.C.B., C.B.E.; Sir Andrew R. Duncan, G.B.E. (Chairman of the Executive Committee); Sir Archibald Page, M.Inst.C.E.; Sir James Lithgow, Bt.; Sir Charles Barrie, K.B.E., M.P.; Col. F. A. Neill, D.S.O. (Master Cutler); Mr. J. Craig, C.B.E.; Sir Allan Powell, C.B.E.; Sir Campbell Stuart, K.B.E.; Sir Frank E. Smith, D.Sc., K.C.B., C.B.E. (Secretary, Royal Society); Sir Sydney Chapman, K.C.B., C.B.E.; Mr. A. Hutchinson, M.A., B.Sc. (President, Iron and Steel Institute); Mr. Benjamin Talbot; Mr. A. K. McCosh; Mr. James Henderson; Mr. A. O. Peech; Sir Evan Williams, Bt. (President, Mining Association of Great Britain); Sir Wm. Gowers, K.C.M.G. (Senior Crown Agent for the Colonies); Sir Charles Bruce Gardner; Sir W. Harry Peat, K.B.E.; Sir Harold Hartley, C.B.E., M.C. (Chairman, Fuel Research Board); Mr. R. F. Summers; Mr. S. Summers; Mr. Charles Mitchell; the Hon. R. D. Kitson, D.S.O., M.C.; Mr. T. G. Bamford (President, Staffordshire Iron and Steel Institute); and others.

THE CHAIRMAN said he had to express regret that Sir Thomas Inskip (who had intended to propose the toast of "The Iron and Steel Industry") was unable to be present. He explained that the Naval Estimates were under discussion in the House of Commons, and as Mr. Duff Cooper, the First Lord of the Admiralty, was ill, it was necessary for Sir Thomas Inskip to take his place on the Front Bench. Sir Thomas, continued the Chairman, had sent him a personal letter expressing his great regret at his enforced absence and at the same time stating that the Government greatly appreciated the wholehearted co-operation which it had already experienced from the iron and steel industry and also of the assurances that had been given him that the Government could rely on the goodwill of the iron and steel industry in the difficulties which confronted the nation at the present time. The Chairman added his own expression of regret that Sir Thomas Inskip was unable to be present and hear personally how willing the industry was to meet all his appeals. He added that the Rt. Hon. W. S. Morrison (Minister of Agriculture and Fisheries) had willingly, at the shortest notice, responded to the request made of him to propose the toast of the industry. Mr. Morrison, he said, was one of the youngest and certainly one of the most able members of His Majesty's Government, and just as he had said, when asked to propose this toast, "Hamar, I will not let you down," so the industry would assure him that they would not let the Government down.

THE RT. HON. W. S. MORRISON (Minister of Agriculture and Fisheries), proposing the toast of "The Iron and Steel Industry," first expressed his personal regret that Sir Thomas Inskip had been prevented from attending, and said he was encouraged, in performing the duty which Sir Thomas was to have performed, by the reflection that agriculture and the iron and steel industry, in their own way, had very similar interests. They were both very important national industries in time of peace and they were vital to the continued existence of the nation in time of war. There was a close connection between the iron and steel industry and the farmer inasmuch as he, so to speak, cleared up the back yard of the iron and steelmakers. He understood that basic slag was produced at the iron and steel works and the farmer, with that obliging nature which had characterised him throughout the ages, removed this stuff from the iron and steelmaker's back yard and actually paid for the privilege of doing so. He hoped this was a matter which the industry would take into consideration and that when the present arrangement came to an end on May 31 next the iron and steelmakers would offer the farmer a reasonable price for removing this stuff from their works!

Speaking of the British Iron and Steel Federation as an organisation, Mr. Morrison said there was a national significance in it and all organisations of a similar character. There were people in this country who, impressed by the regimentation which was to be seen in some foreign lands, sighed for something of that concentration and speed which was associated with those *régimes* and contrasted the doings in foreign countries with debates in Parliament, with letters to the newspapers and other evidences of democracy. But these people were apt to under-rate the real strength and elasticity of the structure under which we lived, and personally he believed that when it came to matters of government and the calls which the Government might have to make on the energies of the people, the existence of voluntary organisations such as the Iron and Steel Federation was a source of strength to the whole nation. Whilst saying this, however, it was necessary at the same time to say a word of praise for those vital partners in the industry, viz., the men who worked in it. Their skill was at the foundation of the success of the industry and it was remarkable testimony to our people in this period of rising costs and rising wages, that adjustments as to wages should have been made with so little friction and so little fuss. It spoke volumes for the statesmanship at the head of the employers' organisations and the trade unions. This all gave him confidence in the strength of the nation.

The toast was coupled with the name of the Chairman (The Rt. Hon. the Viscount Greenwood, P.C.).

Chairman's Response

The CHAIRMAN, responding to the toast, said this was his first speech as President of the British Iron and Steel Federation, and he wished at once to express his profound thanks for the compliment that had been paid him, and the great firm of which he was chairman, and the North-East Coast, which he particularly represented in the industry, for electing him President of the Federation this year. He looked to all the members of the Federation for support and help during what might be one of the most important years in the history of the industry and one of the most fateful in the history of our country.

Continuing, he said the year 1937 had been notable in the history of the steel industry. For the first time steel production reached over one million tons per month, and yet the demand exceeded the capacity of the industry. The imports of semi-finished material and of essential raw materials, together with the increased home production, had been controlled and distributed by the British Iron and Steel Federation in such a manner as to secure maximum production from the existing plants and to maintain supplies for the use of industries. This involved the importation and distribution during the year, in co-operation with the foreign producers, of one million tons of scrap, upwards of half-a-million tons of pig-iron and half-a-million tons of finished steel. During the past five years, some £30,000,000 had been expended on the technical equipment of the plant in the industry, and new productive plants had come progressively into operation. As a consequence, there was every prospect of the demand in the future being met by the employment of our own people in this country and within the Empire, in addition to the imports which, under our international agreement with the Cartel, we had undertaken to purchase. The international agreement had produced similar conditions in the world market and had promoted co-operation between the whole of the iron- and steel-producing countries of Europe. Moreover, our American friends had agreed to co-operate in the export markets of the world, and he welcomed to the dinner Mr. Todd, representing the great iron and steel industry of the United States. If ever there was a time in the history of the world when our great iron and steel industry and the steel industry of the United States should be united with goodwill, this was it, and he for one hoped that that co-operation would not cease with steel. The effect of this co-operation would be to maintain prices at a level which would stimulate production and also secure for all producing countries their proportionate share of world markets, and he hoped that nothing would come to destroy this growing goodwill and co-operation amongst many countries.

We, in this country, continued to devote most attention to the export market, and it was most gratifying to note the resilience of the demand for steel in our Empire markets. Our actual production of steel last year was 4 million tons more than in the war year of 1918, and we were now able to produce more steel than ever before in our history, with greater power of expansion and better equipment, all organised through the Federation as a national unit, ready and willing now to meet any demand the country might make upon the industry. This great industry had at long last regained comparative prosperity, and it was most gratifying to note that that prosperity was shared by the workers in the industry. As a result of the sliding scale, the average weekly earnings of 152,000 men had risen from £3 8s. in December, 1936, to £3 17s. 6d. in the final month of last year, and the employers welcomed the new agreement whereby a large number of the workers would receive seven days' holiday with pay each year, a concession the principle of which had been accepted by the steelmakers from the outset of recent discussions.

Having responded to the toast of the Industry, the chairman proposed the toast of "Our Guests," coupling with it the name of Lord May (chairman of the Import Duties Advisory Committee). In extending a special welcome to the Rt. Hon. W. S. Morrison, the chairman said the speech they had just listened to would stimulate the industry to promote the cause of peace by showing that they were invincible in defence and, at the same time, he assured Mr. Morrison that the whole of the resources of the industry, personal and material, were at the service of the State.

Continuing, the chairman said it was impossible to carry out with such rapidity as we were now doing an immense rearmament programme without any material interference with an unusual volume of commercial requirements, but in spite of this new programme we had been able to develop the resources of the country. After remarking that it was the duty of the State to create conditions in which an efficient self-governing industry became possible, the chair-

man referred to Lord May, who, he said, commanded universal respect and admiration. At the same time, he assured Lord May that on this occasion, at any rate, the industry asked from him no preference, no tariffs, but on the contrary, unrestricted freedom of speech.

In conclusion, the chairman said that our great country and Empire had grown stronger and stronger century by century. To-day we were stronger in men, women and materials than ever before, and we were a more united Empire. We had achieved almost the maximum standards of human freedom and the rule of law prevailed wherever our flag was flying. If he might speak for the iron and steel industry as a whole he would say that they supported the Prime Minister in every step that he might take to maintain inviolate our splendid heritage and to strengthen our country and Empire in order to make it what it ought to be, the greatest instrument for peace in the world to-day.

mendations, in addition to which the Committee was always ready to discuss matters with the industry and give such advice as it was able to give.

In all these circumstances the relations between the industry and the Committee were happy ones and he believed they had been successful. The steps that had been taken had changed the industry from one which had been entirely individualist into one of gigantic co-operation. In any such reorganisation there was always bound to be inequalities but the industry as a whole had been wise enough to realise that such inequalities were more than made up by the general benefit to the industry. It was true that letters were received from time to time complaining of inequality but there was really nothing in them. There had been price agreements for a number of years and the policy aimed at was a moderate price policy with the desire to maintain output, rather than one of

own personal view, however, was that the industry had built on such solid foundations that it would be in much the same position then as it was now. Finally, Lord May said that during 1937 the Imports Advisory Committee had reported, and it was gratifying that that Report had been so well received especially by the iron and steel industry, which indicated that the minds of the industry and of the Committee were on the right lines.

LORD MAY then proposed the toast of "The Chairman," which was briefly responded to by Viscount Greenwood, who again urged the industry to make every effort to be prepared for the possibilities of the future and to place all its facilities at the disposal of the Government in whatever form that might be required.

Amongst those present who are prominent in the foundry industry were :—Dr. C. H. Desch; W. C. Devereaux; C. K. Everitt; V. C. Faulkner, A. A.

ANNUAL DINNER OF THE BRITISH IRON AND STEEL FEDERATION.

LORD MAY, responding to the toast, said all the guests would wish to congratulate the iron and steel industry on the magnificent performance it had put up during 1937. That achievement, however, had only been made possible by five years of strenuous work in the reorganisation of the industry. When the Import Duties Advisory Committee first came into contact with the steel industry, there had been attempts made to improve the position through the Key Industries Duties and Import Duties and the promise was made that the Imports Advisory Committee would do all in its power by way of recommendations to the Government and give it every possible support if the industry were reorganised. An agreement was come to on those lines and he was pleased to say that it had been carried out on both sides honourably and to the letter. The Committee had to consider in those days a position of some difficulty but it accepted the assurances of the industry and pointed out that it was the job of the industry to reorganise itself and that the Committee was not going to try to coerce those engaged in it. Therefore, all the credit was due to the industry for the reorganisation that had taken place, and the Committee had carried out its part of the bargain by making certain recom-

high prices which must inevitably have brought the industry to the depths of depression. During the whole of the time the industry was being reconstructed it had been subject to criticism but he did not mind criticism so long as it was constructive. He had heard people say that the iron and steel industry had the Import Duties Advisory Committee in its pocket and were making inflated profits. That, however, was not true. There were others who said that if the damned Advisory Committee would not "muck about" with the iron and steel industry they would be able to supply what was required. Again, that was not true, and the achievement of 1937 was distinct evidence of that. On the other hand, if there was a substratum of truth in it, then it made the achievement of 1937 all the more wonderful, and again he said he admired and appreciated the enormously great effort that had been made by the industry.

Speaking of the future, Lord May said the industry had achieved what it had at a time of great demand. It was true there had been difficulties during that time. There had been rising prices for what the industry had to buy, and there had been all sorts of difficulties, but they would be in an entirely different situation when there was a falling off in demand. His

Fellows; C. W. Fellows; W. T. Griffiths; Dr. W. H. Hatfield; F. J. Hemming; T. W. Jopling; J. Sinclair Kerr; B. B. Kent; A. A. Liardet; H. W. Lockwood; W. R. Long; G. T. Lunt; Sir Ronald Matthews; Dr. A. McCance; A. N. McQuistan; J. G. Pearce; W. F. Prentice; N. E. Rambush; Dr. T. Swinden; S. Walton; Ashley G. Ward; E. Wharton, and A. Young.

Lubrication and Lubricants

Some time ago the Institution of Mechanical Engineers held a general discussion on Lubrication and Lubricants. Some 29 British and 22 foreign societies agreed to collaborate and, as a result, 136 Papers were received. The Papers deal with the major problems of the subject—practical and theoretical and the correlation of these aspects—the application of bearing design, the relationship of academic research and trade practice, statements of current views on bearing metals, and the significance of laboratory tests, including wear and friction tests. The Papers, together with the summaries by the reporters, the accounts of the discussions, and the collated replies by the authors, constitute an invaluable compendium of current information on lubrication, and an important addition to its literature. The Proceedings will be published later this month, in two bound volumes, comprising some 1,200 pages, price 25s. the set.

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Non-Ferrous Ingot Moulds

INTERESTING DISCUSSION IN LONDON

When Mr. W. A. C. Newman read his Paper on "Some Aspects of the Casting of Commercial Ingots"* to the London Branch of the Institute of British Foundrymen, much useful information was educed. By correlating some of the expressions of opinion with ingot moulds for steelworks and with chills and denseners, some interesting aspects are revealed.

The discussion was opened by MR. G. L. BAILEY, who observed that the author had done extremely well to emphasise so strongly the importance of making good castings. The extra expenditure involved in making first-class castings was very well justified, for the expenditure of even an extra 1d. per lb. of castings might result in a serious saving of expense in later stages, due to less rejects for defective wrought material.

Steel-Lined Moulds

The use of copper moulds would, he suggested, increase rather than decrease, because the iron mould, with all its conveniences and advantages, was certainly open to serious objection on the grounds mentioned by Mr. Newman. A reasonable life for a cast-iron mould was 1,000 heats, as mentioned in the Paper; but in the latter 500 of those heats, the mould was probably not turning out first-quality castings, because it was beginning to deteriorate, and the stage at which it should be rejected must be decided upon according to the expense which its continued use involved. On one occasion he had tried the experiment of lining a cast-iron mould with a thin plate of steel, but his results were altogether different from those of Mr. Newman, and he would like an expression of opinion as to where he had gone wrong. For lining the mould he had used plates ⅛ in. thick. and had cut some grooves down the side of the mould for the plates to slip into, leaving ample room for the expansion of the plates and hoping that they would expand into the grooves. The plates, however, had expanded away from the face of the cast-iron mould, with the result that the ingots produced were much thinner in the middle than at the edges. The plates would not expand in the direction in which provision was made for their expansion.

He had been surprised to notice some time ago the use by gold refiners of a reducing flame on the surface of the ingots during solidification. He could understand the purpose of such a flame during the solidification of an alloy which formed an oxide skin as the result of exposure to the air, which skin was likely to form an uneven surface; but he was under the impression that gold did not form such a skin when exposed to air, and, therefore, he asked why it was necessary to use a reducing flame over the surface of a fine gold bar during solidification in order to ensure that the bar would have a bright, unoxidised surface.

Phosphorus Content of Ingot Moulds

THE BRANCH-PRESIDENT (Dr. A. B. Everest) commented that Mr. Newman was obviously a great authority on ingot moulds, and that some of his ideas were rather refreshing and possibly a little unconventional. For hematite moulds Mr. Newman had mentioned phosphorus contents of 0.4 to 0.6 per cent.; the Branch-President wondered whether he had meant 0.04 to 0.06 per cent. The reference to the Ericsson mould was particularly interesting, and he asked what was the composition of the special strips used in that mould and what expansion characteristic was aimed at.

MR. A. H. SQUIRE asked whether copper moulds were used only for the production of ingots of copper or of copper alloys, and whether attempts had been made to use ingot moulds made of the alloys which it was intended to cast in them. For instance, if a bronze ingot were to be made, could one use a mould made of the same bronze?

Perlit-Iron Ingot Moulds

MR. J. A. SMEETON, M.I.Mech.E., recalled that five or six years ago a company with which he was associated, and which was manufacturing Perlit iron, had made a number of moulds in Perlit iron for several non-ferrous metal manufacturers in Birmingham, who had stated that the Perlit moulds had stood up appreciably longer than any other quality of cast-iron moulds that they had used previously. It was fair to say, however, that Dr. Everest had not at that time developed the nickel irons to the extent to which they were now developed. Perlit moulds did, however, show a minimum growth and had the all-pearlitic structure and close grain which retarded cracking and other faults which were so obvious in the ordinary qualities of cast-iron moulds used previously.

With regard to moulds for steel ingots, he said that at a works on the Rhine recently, he had been amazed to find that after a number of ordinary ingots of open-hearth steel had been poured, the surplus metal in the ladle was used to pour into other moulds for the casting of ingot moulds. They were collapsible moulds which were opened immediately after they were cast, and had normal sand cores. As ordinary open-hearth steel of sheet steel quality was poured into the moulds a workman threw into it some handfuls of ferro-silicon from a bucket, which silicon was said to improve immensely the quality of the metal and render it suitable for such moulds. It was stated that the average mould made of hematite cast iron of the usual quality would last for 65 to 85 fillings, whereas the moulds made of open-hearth steel to which the ferro-silicon was added had lasted 120 to 140 fillings.

Top and Bottom Running

He did not know how far bottom running was applied to non-ferrous metals, but bottom running was considered essential for any good-quality steel ingot. A number of years ago he had been associated with a company in France which had a process for manufacturing cast-steel hollow ingots for the manufacture of tubes. When following up that process in Scotland he had visited a large works in which the men were bottom pouring round steel ingots, using the same process of runners in the base of the mould as was used in the French works for casting the hollow steel ingots. In making the circular hollow steel ingots a refractory core was used, so that when the metal rose and filled the mould it began to contract on cooling, and the core collapsed and permitted the splitting of the cast hollow ingot. The effect of this process was to squeeze all impurities to the top of the ingot, and when a number of the ingots were cut up their whole length there was not a pinhole or a fault of any kind anywhere on the surface. Those ingots were never made in this country, but the experience showed that in 90 cases out of 100 the bottom-run ingot was superior to the top-run ingot because turbulence in the mould was not nearly so great when bottom pouring and there was less tendency to piping than when the ingot was run from the top.

Finally, he said he had not had the pleasure of hearing before any Paper which contained so much valuable and concrete information, and he suggested that the author should be invited to read it again before a combined meeting of the Iron and Steel Institute and the Institute of Metals, because it must be of immense interest to the members of those bodies. He desired to thank the author for having prepared and read a Paper of such vital interest to the foundry industry.

Mould Temperatures

MR. H. O. SLATER (Past Branch-President) asked for information concerning the desirable temperatures for moulds used for copper-nickel, 70/30 brass, aluminium-bronze, and so on, and emphasised also that the pouring rate and the cooling rate were very important. A very old and sound foundry principle was that the equal distribution and solidification of metal was essential to the production of a sound casting.

It was perhaps surprising that the author had achieved a certain amount of success by inserting a steel plate into a mould; he personally had not been able to achieve success in that direction. It would appear that the necessary machining of the mould and the insertion of the plate might cost more than a new mould.

"Bellied" Moulds

MR. J. O. HITCHCOCK referred to the practice adopted in many brass rolling mills of bellying cast-iron moulds, *i.e.*, of bulging them in the centre, and said he understood the idea was that the superficial impurities were thereby collected together in the bellied portion and could be planed off; in that way the amount of scrap was reduced to the minimum.

He had noted that frequently cast-iron moulds were made with front and back of different thickness; indeed, he did not remember having seen any that were of uniform thickness. The varying thicknesses seemed to be irrational, and he asked what was the reason for adopting that practice. One advantage of water-cooled copper non-ferrous moulds was that greater regularity of melting schedule was obtained as compared with cast-iron moulds.

MR. E. H. BROWN, asking for more information with regard to segregation in the silver and copper alloys, said that in the graphs the silver-rich alloys showed a very much slower movement from the segregation point than did the copper-rich alloys. He asked whether there was any critical range, in the case of any particular alloy, within which that effect could be minimised.

Superiority of Crucible-Cast Ingot Moulds

MR. A. J. MURPHY, referring to specifications of iron for chill moulds, expressed the opinion that the main point was to ensure a uniform structure throughout the casting, and believed that for this reason a crucible-melted iron casting gave a better life as a mould than one which was cast direct from the cupola.

It was by no means easy to secure a sound casting in high-conductivity copper, and for normal production the use of 2 per cent. of zinc in the copper greatly facilitated casting. Of the common metals zinc had the least deleterious effect on the conductivity of the base metal. By simple means such as those one could retain good conductivity with reasonably easy casting.

He was in great sympathy with the reference to the troubles arising from the use of excessive amounts of dressing. It had been suggested, however, in that connection, that by means of a heavy dressing with certain copper alloys, provided the entrapping of vapour bubbles could be avoided, an appreciable grain-refinement was obtained. No doubt the reason was the fairly intense vibration which occurred in the metal just as it was on the point of solidification. This probably lay behind the preference of some casters for heavy coatings of dressing.

AUTHOR'S REPLY

MR. W. A. C. NEWMAN, B.Sc., replying to the discussion, first paid tribute to the tremendous amount of work done by Mr. Bailey and

* FOUNDRY TRADE JOURNAL, March 17, pp. 239-43.

STAVELEY

have invented an entirely New Flexible Joint.

An important announcement to users of Cast Iron Pipes will be made in this journal shortly.

Dr. Genders in the investigation of ingots and ingot moulds, and said that anyone who had any connection at all with ingot casting was extremely indebted to them for their work.

The decision as to the exact stage at which it paid to reject a mould was always difficult. The management wanted the maximum life from a mould, but the men who were working with it wanted to scrap it as soon as it deteriorated to a stage at which it appeared to affect the ingots produced. An advantage of the casting of copper moulds on the spot was that the scrapped mould castings provided the material for new moulds, and they went back into the furnace at the ordinary price, whereas an ordinary cast-iron mould which was scrapped would command only scrap price.

Steel-Lined Moulds

With regard to the use of plates for lining moulds, he said he had mentioned it provocatively, with a view to getting ideas. In ordinary strip moulds, which were placed back-to-back, the back always deteriorated first, probably due to the stresses produced in casting the mould itself, so that the efficiency of the mould was impaired before the internal recessed part deteriorated to any appreciable extent. Frankly, he had not expected that the fitting of a very mild steel plate would assist in any degree at all, and so far he had used only about half a dozen. The experiment had been tried with ordinary strip moulds, the sheet metal being cut into plates to conform to the shape of the moulds and placed next the backs. The moulds were not screwed up tight, but were given just a grip fit, so that a certain amount of play was left to accommodate movement both vertically and laterally. It was surprising to find that there was not much buckling of the plates, and after 700 heats the surfaces had remained reasonably good, so that the lives of the moulds were prolonged considerably. The moulds themselves cost about £1 each, and the cost of the fitting of a plate was about 3s. 6d. The life of a mould was from 1,000 to 1,400 heats ordinarily, but by fitting a plate, at a cost of 3s. 6d., a mould could be made to give another 600 or 700 heats, which was reasonable economy. He did not claim that the experiment was completely successful yet, but a certain amount of progress had been achieved and the work was continuing.

Reducing-Flame Action on Gold

He had been rather astonished, as Mr. Bailey was, by the effect of the reducing flame on the surfaces of gold ingots, and he could only attribute it to entangled air coming to the surface and combining with the reducing gases, so that it was dispersed. That seemed to be the simplest explanation. It was certain, however, that if a reducing flame were not used over the surface, the appearance of a gold ingot was very unsatisfactory and it was unacceptable to the caster or the bullion dealer. The bullion dealer, even if he knew nothing at all about metallurgy or casting, insisted upon a decent-looking ingot.

The phosphorus content of the hematite iron referred to by the Branch-President was from 0.4 to 0.6 per cent., the phosphorus being added specially. There was great controversy between the advocates of high-phosphorus content and of low-phosphorus content. The chief advantage of high-phosphorus content was that it gave the metal greater flowing power, and it was also felt generally that the structure was somewhat more uniform.

The British Cast Iron Research Association had recently tried a process involving the addition of a small quantity of titanium to a melt of high-carbon iron—No. 3 hematite iron—and the treatment of that material in the molten state with carbon dioxide. That was quite an unusual procedure, and the structure obtained was said to be of the very fine graphitic type, approaching the one originally suggested by Pearce as being most suitable. That work, and a great deal more useful work of a similar character, had been done under the ægis of the Committee set up by the Iron and Steel Institute to consider the heterogeneity of steel ingots.

Replying to Mr. Squire's question as to whether it would be possible to use moulds of the same composition as that of the alloys cast in them, he suggested that that would be impossible, for the reason that alloys generally had inferior thermal properties, their conductivities were very low, and the heat would not be conducted away sufficiently quickly to prevent the adhesion of the ingots to the moulds in which they were cast.

Steel Moulds

The remarks of Mr. Smeeton concerning Perlit iron moulds were of particular interest, because it was an accepted opinion in some quarters that a pearlitic structure was desirable in a mould. It was rather surprising to hear that satisfactory results were obtained with steel moulds. For non-ferrous ingots, steel moulds were taboo, because of the probability of the welding of the ingots to the steel. He had seen silver-base alloys attach themselves to the steel when it and cast iron were used together in a mould. In one instance the bottom plugs in the strip moulds were accidentally made of steel instead of iron, and all the plugs had pulled.

With regard to horizontal *versus* vertical moulds, he said the tendency was to cast wire bars and anodes in vertical rather than horizontal moulds, because there was less danger from contamination from the oxygen of the air, and the properties of the bars were better generally.

Ingot-Mould Temperatures

Dealing with Mr. Slater's question concerning the proper temperatures of moulds for casting various alloys, Mr. Newman said he could not at the moment go through the whole series of alloys, but for most base metals and precious metals he liked to heat the moulds to about 150 to 180 deg. C. Strangely enough, unusual circumstances were experienced three or four weeks ago, when the moulds used for casting bronze were actually red hot at about the fourth cast. The strips cast in those moulds were placed on one side and were rolled separately, and to his surprise there was not much difference between the rolling properties of those strips and of strips which were cast in moulds the temperature of which did not exceed 200 deg. C.; the only real difference was that the strips cast in the red hot moulds tended to split a little.

He agreed with Mr. Hitchcock that it had been the practice to "belly" cast-iron moulds, with the idea of segregating the impurities in the bellied portion, and planing that portion away. The point against it was the expense of producing the moulds in the first place with the bellied portion. Another reason for the use of bellied moulds was that the bellied portion should take up the contraction which occurred along the length of the ingots made of certain alloys, thus ensuring that the ingots produced would be parallel-sided. He preferred that the thickness of a mould at front and back should be uniform, in order to secure uniform heating all round.

Silver Alloys

Replying to Mr. Brown, he said that in silver-copper the minimum segregation occurred in the eutectic alloy, where there was a single melting point and the whole of the metal solidified at one temperature. In the silver-rich alloys, containing more than the eutectic composition, there was enrichment in the centre, and in the copper-rich alloys, containing less than the eutectic composition, there was enrichment at the edge.

With regard to Mr. Murphy's reference to crucible-melted *versus* cupola iron, he said that an advantage claimed by some people for cupola iron was that it would retain its characteristics longer than the directly-melted metal. He agreed with Mr. Murphy that the addition of a small amount of zinc to copper assisted the casting of the copper moulds themselves; indeed, the effects of small proportions of impurities on the casting of pure metals was remarkable. It was difficult to produce a sound casting in pure silver, by reason of the extreme absorption of oxygen by the silver; but if only ½ per cent. of copper were added it was quite possible to produce a perfectly sound casting.

Vote of Thanks

MR. A. J. MURPHY, proposing a hearty vote of thanks to Mr. Newman for the charming and easy way in which he had dealt with the casting of commercial ingots, emphasised that the subject was of fundamental importance because a very large proportion of the metallurgical industry must stand or fall by the quality of the material it received in the form of ingots.

DR. L. B. HUNT, seconding the vote of thanks, said that while the problems of ingot casting were in some ways simple, in other respects they were very involved, particularly in connection with rate of cooling, turbulence and mechanical pouring. Very much thought had been given to these matters and many of the ideas developed could very well be applied to certain aspects of foundry work. That was a further reason for gratitude to Mr. Newman for his very interesting Paper.

The vote of thanks was carried with acclamation.

Iron and Steel Import Duties

REVERSION TO PREVIOUS RATES

The Import Duties Advisory Committee call attention to the fact that the period for which reduced rates of Customs duties on certain iron and steel products were established as a temporary measure will expire on March 31.

The Committee do not propose to make any recommendation for the continuance of reduced rates of duty on those products after that date.

This decision is in accordance with general expectations. During the period of exceptional demand last year it was decided to admit imports from Cartel countries at 2½ per cent. duty and other imports at 12½ per cent. The need for stimulating imports no longer exists, and the duties, by the Advisory Committee's decision, will revert to the levels existing prior to July of 1937. The rates that will operate will be 10 per cent. in the case of licensed imports from Cartel countries, and on unlicensed imports—tonnage in excess of the quota from Cartel areas or material from non-Cartel districts—they will vary from 20 per cent. to 33⅓ per cent., *ad valorem*, with specific duties of varying amounts which will range between these two figures.

Notched-Bar Impact Testing

The Joint Committee on Materials and Their Testing draw attention to the publication of the reprints of the first General Discussion held under their auspices in Manchester in October last. All the Papers on notched-bar impact testing then presented, with the report of the discussion and communications, are now available as excerpts from the Transactions of the Manchester Association of Engineers, which undertook responsibility for the publication as well as for the local arrangements. The titles of the four Papers included in the reprints are as follow:—(1) "Impact Testing from a Physical Standpoint," by Prof. R. V. Southwell, M.A., F.R.S., University of Oxford. (2) "Some Aspects of the Notched Bar Test," by L. W. Schuster, M.A., British Engine and Boiler Insurance Company, Manchester. (3) "The Development and Present Position of Continental Research on the Notched Bar Test," by Dr. Ing. Max Moser, Friedr. Krupp A.-G., Essen. (4) "Discussion of the Impact Test," by Capt. R. K. Haskell and H. C. Mann, U.S. Ordnance Department, Watertown Arsenal. Copies of the volume are available in stiff paper covers at the price of 3s. 6d., post free, from the Secretary, Manchester Association of Engineers, St. John Street Chambers, Deansgate, Manchester, 3.

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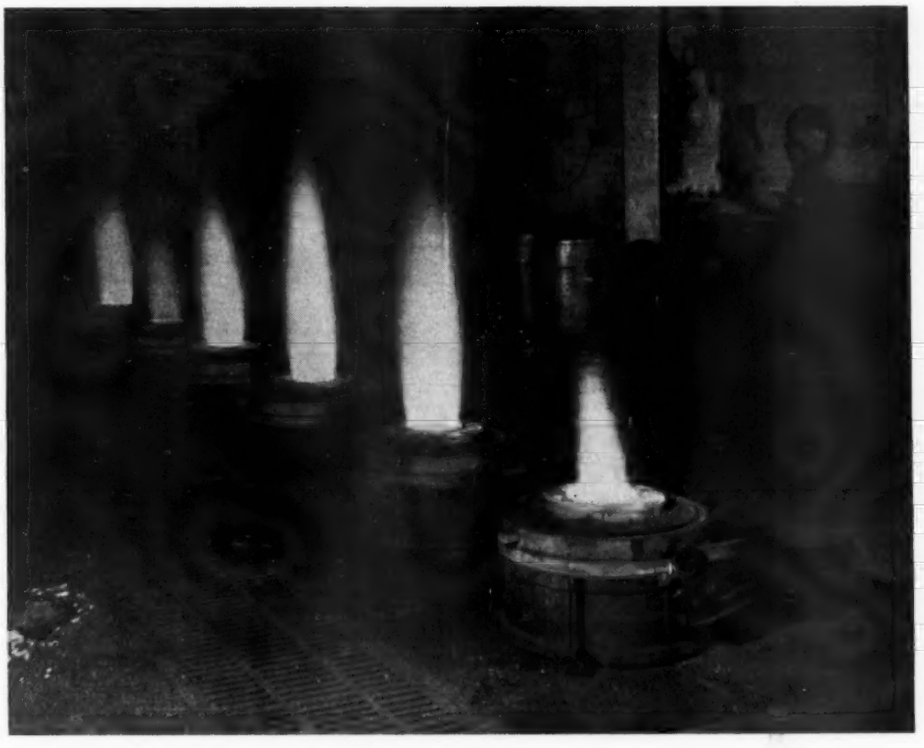

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The Week's News in Brief

Trade Talk

BLYTH DRY DOCKS & SHIPBUILDING COMPANY, LIMITED, have received an order for two more boom defence vessels for the Admiralty.

THE HAMMOND LANE FOUNDRY COMPANY, LIMITED, Dublin, which has been established 35 years, covers an area of eight acres and employs over 800 hands, had a full range of its manufactures in the imposing Irish Industry Parade held in Dublin last Saturday.

THE ELEVENTH ORDINARY MEETING of the British Society for International Bibliography will be held in the Council Room of the Science Museum, London, on March 31, at 5.15 p.m. Mr. Basil U. J. Brajnikoff will address the meeting on the subject of "Abstracting Russian Literature."

OVER 200 PEOPLE attended the annual staff dinner, whist-drive and dance of Urquhart, Lindsay & Robertson Orchar, Limited, of Dundee. Mr. J. Wright (director) presided at the dinner, and Mr. Keith Anderson (general manager of the firm's Wallace Foundry) proposed a toast to the guests.

INTERNATIONAL COMBUSTION, LIMITED, Derby, have secured several contracts from home and abroad. Among them is one from the Metropolitan Borough of Poplar, for three boiler conversions, and the plant to be supplied will include three stokers. The Bunnererong Power Station, Sidney, Australia, have placed a contract for a complete coal-handling plant.

MR. GILBERT M. SHANKS, joint managing director of Shanks & Company, Limited, of Barrhead, speaking at the annual meeting on March 17, pointed out that although the lull in the housing trade continued, public work was still very active, and should show no slackening for some time to come. A renewal of overseas buying was expected when price levels became steadier. The company had the contract for the complete sanitary equipment of the new liner, "Queen Elizabeth."

THE ANNUAL REPORT of J. Brockhouse & Company (Ireland), Limited, ironfounders, records a loss for the year ended October 31, 1937, of £6,139, compared with a loss of £5,534 for the period August 28, 1935 (date of incorporation), to October 31, 1936, making the debit balance to be carried forward £11,723. The report states that the appointment of Mr. J. T. Brockhouse as managing director ceased as at January 28, 1937, and that Mr. E. Burton Burton vacated his position as director on August 3, 1937. No reference is made to the progress in the current year.

THE EIGHTEENTH annual works dinner of Qualcast, Limited, was held last Saturday in the Drill Hall, Derby. Mr. V. Jobson presided, and presented clocks for long service to Mr. Arthur Rowe (57 years' service); Miss N. Stirland and Miss M. C. Roome (both ten years), and Mr. M. Murden and Mr. F. Roberts (both twenty years). Gold watches were presented to Mrs. M. W. Amatt (20 years' service) and Mr. J. Kirk (40 years' service). Referring to Mrs. Amatt, Mr. Jobson said she was the third generation to serve with his family, his firm having originally been established in Sheffield in 1801. He announced that all records had been broken during 1937 for output, profit and money paid in wages. Amongst the guests, who included both customers and suppliers, were Mr. V. C. Faulkner and Mr. Victor Stobie (both past-Presidents of the Institute of British Foundrymen), and Mr. Howard Wood.

Non-Destructive Testing

(*Concluded from page* 258.)

to cold deformation, so that some residual magnetism existed. He stated that it is immaterial whether the stresses are compressive or tensile, nor does it matter whether they are of thermal or mechanical origin. He adds that flaw pictures of this kind differ from actual defects, since they can be made to disappear by strong magnetisation, by demagnetisation or by heating to a minimum temperature of 250 deg. C.

Some few years ago some aero push rods, which were actually cold-drawn tubes, were rejected wholesale as a result of routine examination by means of the magnetic ink-spraying test. Some of the returned tubes were examined, and indications were obtained of longitudinal cracks which, however, might have been, and in fact looked like, minute die scratches as a result of cold-drawing operation. A number of these tubes were cut up and carefully examined under the microscope, but in no instance could any crack or offending non-metallic inclusion be found. That case has provided much food for thought, and it may be that the investigations of Holtschmidt provide the clue.

The whole array of non-destructive tests are therefore useful at some point or other, but a great deal of judicious care is necessary in selecting any one for application to a particular problem.

Personal

DIPL.-ING. PAUL SCHWIETZKE, whose election as President of the International Committee of Foundry Technical Association was briefly announced in the JOURNAL last week, is 56 years of age. He was trained in foundry and metallurgical practice from youth onwards, attending the Technische Hochschule at Aachen, where he obtained his diploma. He is director and proprietor of Metallwerke J. G.

Schwietzke, Düsseldorf, a family concern since 1870, and now employing 500 men. Mr. Schwietzke resigned after many years' service from the chairmanship of Gesamtverband deutscher Metallgiessereien when elected director of the non-ferrous foundry subgroup and vice-director of the Foundry Industrial Group of Germany. The new organisation contains altogether about 1,500 non-ferrous foundries. As member of the German Standards Institution he has collaborated in drawing up the standard specifications for copper and copper alloys. For many years he has also been a member of the Advisory Committee of the Control Board for Base Metals, *i.e.*, the official body controlling the supply of raw metals in Germany.

BREVET-COLONEL C. A. LINDOP, of H. W. Lindop & Sons, malleable ironfounders, and Mr. W. R. Wheway, a director of J. Wheway & Son, Limited, chainmakers and malleable ironfounders, have been appointed Justices of the Peace for Walsall.

MR. J. L. ADAMSON, chief engineer at the Skinningrove Iron and Steel Works, Saltburn, has been appointed to the position of works manager previously held by Mr. Frank Bainbridge, who died recently. Mr. T. Teasdale, chief electrician at the works, has been appointed to succeed Mr. Adamson as chief engineer.

MR. NORMAN F. S. WINTER, of Spermolin, Limited, had the honour of being presented to His Majesty at the levée at St. James's Palace on March 17. Mr. Winter, who is also chairman of the Halifax waterworks undertaking, was previously presented to the King and Queen during their northern industrial tour last autumn.

MR. HAROLD W. SECKER and Mr. Harold Vernon have been appointed full directors of Thos. W. Ward, Limited, of Sheffield, and Mr. Joseph Staves, Mr. William Wood, Mr. H. Glover Faull and Mr. C. Leslie Fry have been appointed local directors. These appointments have been made in order to cope with the increasing ramifications and responsibilities of the company.

Obituary

MR. WILFRED EDWIN SMEDLEY, who has died at the age of 69, was for 55 years associated with the Park Foundry, Belper, retiring about two years ago. The foundry was started by his father.

MR. THOMAS HENRY PARROTT, chairman and managing director of Belliss & Morcom, Limited, engineers, of Birmingham, died on Saturday, March 12, at the age of 71. He had been associated with the company for more than 55 years. He was apprenticed to the late Mr. George E. Belliss in 1882. At that time the firm was engaged principally in the construction of marine engines and boilers, and Mr. Parrott spent considerable time at Devonport, where British gunboats were fitted out by the firm. Later he became works manager at the Ledsam Street works at a time when the business was being reorganised owing to a change in its scope. At that period the electrical supply industry was coming to the fore, and Mr. Parrott supervised the construction of reciprocating engines supplied for many generating stations in this country, on the Continent, and in the Dominions. He played an important part in the erection of new works and in extensions and equipment of the firm's premises. He became managing director about 25 years ago and chairman in 1930. He was a member of the Institution of Mechanical Engineers for 45 years.

MR. H. W. CLOTHIER, a director of A. Reyrolle & Company, Limited, has died in Auckland, New Zealand, where he had to undergo an operation while in the course of a business tour. Mr. Clothier's main life's work was done in his long association with A. Reyrolle & Company, Limited. He retired from some of his executive activities in April, 1937, but he continued to act in an advisory capacity on the work he had previously controlled. This change freed him for the tour on which he was engaged. Mr. Clothier was born in London in 1872, and after an apprenticeship and some subsequent work with J. & H. Gwynnes, Hammersmith, he was for about ten years first with the late Dr. S. Z. de Ferranti and Mr. C. P. Sparks in London, and then at Hollinwood in charge of many matters connected with the design of Ferranti's switchgear and transformers. In 1905 he went to Tyneside to begin an investigation of protective gear for electric power generation, transmission, and distribution systems at the suggestion of Mr. C. H. Merz and Mr. Bernard Price. While thus engaged, his attention was directed to the improvement of high-voltage switchgear, and he then produced the original designs of the metal-clad draw-out type. In 1906 he joined the staff of A. Reyrolle & Company to supervise and direct the developments with which his name, as well as that of Reyrolle's, will always be linked. His unceasing advocacy of the need for continuity in the supply of electricity and for safety of human life in its use has borne large fruit.

Contracts Open

Falkirk, March 31.—Iron and steel pipes, for the Stirlingshire and Falkirk Water Board. Mr. J. Cullen, engineer, Water Board Offices, "Belmont," Falkirk.

Southend-on-Sea, March 30.—Pumping machinery for the Town Council. Rofe & Raffety, consulting engineers, 208, Abbey House, Victoria Street, Westminster, S.W.1. (Fee £2 2s., returnable.)

Forthcoming Events

MARCH 31.

Institute of Metals (London Section):—Annual general meeting and open discussion, at Society of Motor Manufacturers and Traders, 83, Pall Mall, London, S.W.1, at 7.30 p.m.

Institute of British Foundrymen

APRIL 1.

Birmingham, Coventry and West Midlands Branch:—Annual general meeting and Short Paper Competition, at James Watt Memorial Institute, Great Charles Street, Birmingham, at 7.30 p.m.

APRIL 2.

Lancashire Branch:—Annual general meeting, at Engineers' Club, Albert Square, Manchester, at 4 p.m.

West Riding of Yorkshire Branch:—"Moulding Sands," Paper by A. W. Walker and S. Carter, at Technical College, Bradford, at 6.30 p.m.

The Institute of Vitreous Enamellers

MARCH 31.

Southern Section:—"Some Thoughts on the Manufacture and Use of Sheet Iron for Enamelling." Paper by J. S. Walton, at Charing Cross Hotel, London, at 8 p.m.

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MIDDLESBROUGH OFFICE : Halifax Bldgs., Exchange Place, Telephone : Middlesbrough 3313. Telegrams : "Genefax, Middle brough." (Mr. J. A. Williams).

CARDIFF OFFICE : 17, Windsor Place, Telephone : 5796. Telegrams : "Genefax, Cardiff." (Mr. F. E. Rutter).

Raw Material Markets

Owing to the absence of demand for pig-iron, some furnaces have already been put out of blast and others are likely to follow unless an early indication of improvement is forthcoming. On the surface, it would appear that quiet conditions are likely to continue, but it is known that many consumers are covered only up to the end of the first half of the year, while others have contracts due to terminate at the end of this month. The speeding up and extension of the rearmament programme should result in the strengthening of the markets for iron and steel.

Pig-Iron

MIDDLESBROUGH.—Consumers continue to show little interest in new business. Although in many cases contracts are due to expire very shortly, users are in possession of quite substantial stocks and heavy deliveries are still due. Producers, also, are well stocked with iron. For delivery to Middlesbrough and district up to the end of June, No. 3 Cleveland G.M.B. foundry iron is quoted at 109s., less 5s. per ton rebate. Foundry iron prices may be reduced at the end of the first half of the year, but hematite quotations are fixed over the whole of the year and it is denied that any changes will be made before that time. Meanwhile, the market is quiet, but it is hoped that, under the influence of the rearmament programme, consumers' requirements will steadily expand in the near future. Export trade is negligible.

LANCASHIRE.—New orders in foundry iron are still only for small tonnages and the immediate outlook cannot be said to be particularly encouraging. Activity among the textile-machinery makers and the light-castings founders remains unsatisfactory. For delivery to users in the Lancashire price zone, Staffordshire and Derbyshire brands of No. 3 foundry iron are quoted on the basis of 114s., with Northants at 112s. 6d. and Derbyshire forge iron at 111s. to 113s., according to the class of user. West Coast hematite is on offer on the basis of 141s. and East Coast material at around 140s. 6d., both delivered equal to Manchester. Business in hematite is difficult to obtain, but some improvement is expected shortly.

MIDLANDS.—There have been indications of slightly better activity in the motor trade, but, otherwise, the market is still very quiet. It is suggested that some furnaces will shortly be put out of blast, as makers do not desire to keep heavy stocks owing to the expenses involved. A few small orders are being placed, but contracts involving heavy tonnages are not now being entered into. The market for low-phosphoric iron remains quite strong and consumers are calling for good supplies. The motor-car trade has recently bought substantial tonnages, thus giving rise to the belief that this section is embarking upon better times. Prices continue to range from £6 5s. to £7 7s. 6d., delivered to works in Birmingham and the Black Country. There have recently been more inquiries about for refined iron. The Association price is £8 5s., but this figure is being cut by furnaces outside the Association. There is no change with regard to hematite and the demand continues to be weak.

SCOTLAND.—It is thought likely that the duty on pig-iron will be reimposed at the end of the month; if this is done there should be an early return to more active conditions in the market, which at present is very dull. No. 1 foundry iron is quoted at 120s. 6d., with No. 3 at 118s., f.o.t. furnaces. Many of the light-castings foundries remain on short time. Hematite and basic are being used in heavy tonnages by the local steelworks. Hematite mixed numbers are quoted at 133s., Scottish basic at 107s. 6d., and English and Indian basic at 100s., all less 5s. rebate.

Coke

Hand-to-mouth buying continues to predominate and contracts for heavy tonnages are not favoured at the present time. For delivery to Birmingham and district, best Durham foundry coke is quoted at 55s. 9d., with Welsh coke at from 55s. to 62s. 6d. per ton.

Steel

The steel market has developed rather more activity, and it seems possible that the usual spring demand is beginning to make itself felt, states the official report of the London Iron and Steel Exchange. In some sections of the market considerable stocks have accumulated, but large tonnages are passing into consumption and specifications against contracts are coming forward with regularity. Most of the consuming industries appear to be well supplied with work, so that a steady demand for steel materials may be expected for some months. Similar conditions prevail in the semi-finished steel section of the market, and many consumers are holding large stocks. There is, however, a strong demand for certain descriptions of British material, and if the anticipated spring demand sets in the position should soon be rectified. Great activity prevails in the finished steel department, and the heavy steel makers continue to operate at full pressure. In one or two of the lighter branches business has fallen off, but this is regarded as a temporary phase and consumers are taking good quantities against contracts. The export trade fails to show any sustained improvement, but there has been a steady demand from Empire countries.

Scrap

Supplies of all grades of iron and steel scrap are plentiful and easy conditions rule in all districts. With the exception of the steelworks, which, generally, are still taking up heavy supplies, consumers are displaying little interest in new business. In some cases, however, steelworks are putting furnaces out of commission, with a consequent reduction in the consumption of scrap. Business appears to be most active in Scotland, where the steelworks are well placed for orders.

Metals

Copper.—Another week of quiet business has been experienced and the outlook is still uncertain, much depending on the international situation. Little improvement is noticeable in the United States and new business is in small compass.

Metal Exchange quotations were as follow :—

Cash.—Thursday, £40 13s. 9d. to £40 16s. 3d.; Friday, £40 11s. 3d. to £40 12s. 6d.; Monday, £40 7s. 6d. to £40 10s.; Tuesday, £40 to £40 1s. 3d.; Wednesday, £39 3s. 9d. to £39 6s. 3d.

Three Months.—Thursday, £40 18s. 9d. to £41; Friday, £40 15s. to £40 16s. 3d.; Monday, £40 12s. 6d. to £40 13s. 9d.; Tuesday, £40 5s. to £40 6s. 3d.; Wednesday, £39 8s. 9d. to £39 10s.

Tin.—An outline of the proposal put forward by the Buffer Pool Sub-Committee of the International Tin Committee shows that the pool will buy tin when the price falls below £200 per ton, and sell when it rises above £230. Between those levels it will not operate, but the limits may be varied if any marked change in price levels renders it necessary. It will be started with contributions equal to 7½ per cent. of standard tonnages, which will be forfeited if any signatory fails to produce them, in which case the unfulfilled balance will be redistributed among the other signatories in proportion to their standard tonnages. The pool will remain in operation as long as the tin control scheme, which came into existence on January 1, 1937, for five years. Any signatory failing to produce its proportion will waive the rights which it now enjoys under Article 22 of the International Tin Agreement to withdraw from the restriction agreement. The pool will be controlled by a small body appointed by the International Tin Committee, but not necessarily containing a member of that Committee, and it must not contain any person commercially concerned with the production or marketing of tin. Its operations will be confined to the London Metal Exchange, and the members of the operating body must reside in London. The pool stock will be publishable at the start, but afterwards its operations will be secret. The premiums on the particular brands of the metal will be returnable to the producers, and operations will be confined to standard warrants. The scheme does not contain any provisions for financing the pool.

In London Metal Exchange circles there is general opposition to the scheme, although it is thought likely that the establishment of a pool will take place shortly. As yet, the reaction in London to the negotiations has not been particularly strong, but it is considered that the establishment of a pool will be followed by violent price fluctuations. Little surprise has been given by the publication of the outline, referred to above, although the selling price of £230 is perhaps generally considered to be rather excessive.

It has been announced that the referendum of the Malayan tin producers on the buffer pool scheme will not be held before April 4, thus giving rise to the suggestion that the meeting of the International Tin Committee, scheduled for April 5, will be postponed.

Official quotations were as follow :—

Cash.—Thursday, £184 12s. 6d. to £184 17s. 6d.; Friday, £184 10s. to £184 15s.; Monday, £184 10s. to £184 15s.; Tuesday, £185 10s. to £185 15s.; Wednesday, £184 10s. to £184 12s. 6d.

Three Months.—Thursday, £184 15s. to £184 17s. 6d.; Friday, £184 17s. 6d. to £185; Monday, £184 17s. 6d. to £185; Tuesday, £185 15s. to £186; Wednesday, £184 15s. to £185.

Spelter.—It is anticipated that the Government's efforts to speed up their plans for rearmament will result in a heavy demand for high-grade zinc. Meanwhile, the market is quiet, although there have recently been indications that buyers are about to take up additional supplies.

Daily market prices :—

Ordinary.—Thursday, £14 16s. 3d.; Friday, £14 17s. 6d.; Monday, £14 17s. 6d.; Tuesday, £14 13s. 9d.; Wednesday, £14 5s.

Lead.—Prices have been firm during the past week and it is believed that, if political influences could be overcome, there would be some good business offering in the market. As it is, only cable and battery makers are operating satisfactorily. The February returns from the building trade are not satisfactory considering the more cheerful returns for the two previous months. The total in February was £7,736,200, a decline of 26.8 per cent. from the figure for February, 1937. Whereas in the two previous months plans for housing showed substantial increases, more than offsetting declines in all the other sections, the housing figures for February fell from £5,222,000 to £4,648,800. All other sections again showed declines.

The Metallgesellschaft announces that the world's smelter output of lead in January totalled 137,319 metric tons, against 147,743 tons in the previous month.

Day-to-day quotations :—

Soft Foreign (Prompt).—Thursday, £16 11s. 3d.; Friday, £16 17s. 6d.; Monday, £17 2s. 6d.; Tuesday, £16 15s.; Wednesday, £16 1s. 3d.

Scrap.—A dull tone persists in the non-ferrous scrap market and new business only involves very small tonnages in most instances. Prices are unchanged on the week.

Approximate selling prices for old metal:—New aluminium cuttings, £80; rolled, £63; cast, £38; foil, £88. Copper, £37 to £39; braziery, £33 to £34. Brass (clean), £23 to £25. Zinc, £7 10s. Lead, £12 10s. Gunmetal, £37 to £39.

Company Reports

Crabtree Electrical Industries, Limited.—Interim dividend of 5 per cent.

Broom & Wade, Limited.—Interim dividend of 7½ per cent. on the ordinary shares.

John Baker & Bessemer, Limited.—Dividend of 7½ per cent. on the ordinary shares for 1937.

Hadfields, Limited.—Final dividend of 15 per cent. on the ordinary shares, making 22½ per cent. for 1937.

Blythe Colour Works, Limited.—Final dividend on the ordinary shares of 12½ per cent., making 17½ per cent. for the year.

Thos. Firth & John Brown, Limited.—Final dividend of 11½ per cent. actual, free of tax, making 17½ per cent. actual, free of tax, on the ordinary shares for the year ended December 31.

Switchgear & Cowans, Limited.—Net profit for 1937, £53,618; brought in, £5,057; taxation, including N.D.C., £18,141; dividend of 20 per cent.; to general reserve, £15,000; carried forward, £7,534.

Coventry Machine Tool Works, Limited.—Net profit for 1937, £14,389; to capital reserve, representing profit for the period prior to date of incorporation, £1,439; income tax and N.D.C., £4,300; dividend of 8 per cent., £6,000; to development reserve, £507; carried forward, £2,143.

W. Canning & Company, Limited.—Profit for 1937, after depreciation, income tax, and N.D.C., £87,156; brought in, £28,292; to general reserve fund, £10,000, reserve for contingencies, £5,000; interim dividend of 5 per cent., £11,250; final dividend of 5 per cent., £11,250; a bonus of 3s. per share, £33,750; employees' benevolent trust fund, £3,000; carried forward, £41,198.

IMPROVED HIGH SPEED, INTENSIVE,

SAND MIXING MACHINE

ALL BALL BEARING

Wear plate renewed without dismantling machine.

Enquire for other equally improved features.

The mixer can be supplied as a single unit, or with

ELECTRIC BUCKET LOADER,
AERATOR.
SCREENING PLANT &
CONVEYOR

SPECIALISTS

COGGON FOUNDRY EQUIPMENT LTD Ovenden HALIFAX

Phone: 2423 HALIFAX Grams: COGGON, HALIFAX

"TITAN"

Low Phosphorus
Scotch Quality

ALL-MINE PIG IRON

G. & R. THOMAS LTD

HATHERTON BLAST FURNACES

BLOXWICH • STAFFORDSHIRE

Telegrams: Thomas, Bloxwich Telephone: Bloxwich 6341

RAW MATERIALS—PRICE LIST

(Wednesday, March 23, 1938)

COPPER

	£	s.	d.
Standard cash	39	3	9
Three months	39	8	9
Electrolytic	43	0	0
Tough	41	18	9
Best selected	42	8	9
Sheets	74	3	9
India	55	1	3
Wire bars	43	13	9
Ingot bars	43	13	9
H.C. Wire rods	47	3	9
Off, av. cash, Feb.	39	12	10½
Do., 3 mths., Feb.	39	17	1½
Do., Sttlmnt., Feb.	39	13	0
Do., Electro, Feb.	43	19	2¼
Do., B.S., Feb.	43	10	7½
Do., Wire bars, Feb.	44	7	1½
Solid drawn tubes			12¼d.
Brazed tubes			12¾d.
Wire			8¼d.

BRASS

Solid drawn tubes	11¼d.
Brazed tubes	13¾d.
Rods, drawn	9d.
Rods, extd. or rlld.	6¾d.
Sheets to 10 w.g.	8¾d.
Wire	8¼d.
Rolled metal	7¼d.
Yellow metal rods	6¼d.

TIN

	£	s.	d.
Standard cash	184	10	0
Three months	184	15	0
English	184	10	0
Bars	186	10	0
Straits	186	0	0
Eastern	186	15	0
Banca (nom.)			—
Off. av. cash, Feb.	183	5	3¾
Do., 3 mths., Feb.	183	2	9¾
Do., Sttlmt., Feb.	183	4	6

SPELTER

	£	s.	d.
Ordinary	14	5	0
Remelted	12	0	0
Hard	11	15	0
Electro, 99.9	18	1	3
English	15	17	6
India	14	0	0
Zinc dust	20	15	0
Zinc ashes	5	10	0
Off. aver., Feb.	14	9	11⅝
Aver., spot, Feb.	14	8	1⅞

LEAD

	£	s.	d.
Soft foreign, ppt.	16	1	3
Empire (nom.)	17	12	6
English	18	0	0
Sheets, home	24	15	0
Do. export	20	17	6
Pipes, home	24	5	0
Do. export	21	10	0
Tea lead	33	2	6
Off. aver., Feb.	15	9	3⅜
Aver., spot, Feb.	15	8	0½

ALUMINIUM

Ingots	£100 to £105
Wire	1/3 to 1/4 lb.
Sheet and foil	1/2 to 1/4 lb.

ZINC SHEETS, &c.

	£	s.	d.		£	s.	d.
Zinc sheets, English	29	5	0	to 29	15	0	
Do., V.M. ex-whse.	29	5	0	to 29	15	0	
Rods				21	0	0	

ANTIMONY

	£	s.	d.		£	s.	d.
English	81	0	0	to 82	0	0	
Chinese, ex-whse.				67	0	0	
Crude, c.i.f.				40	0	0	

QUICKSILVER

	£	s.	d.
Quicksilver	13	0	0

FERRO-ALLOYS AND STEEL-MAKING METALS

	£	s.	d.		£	s.	d.
Ferro-silicon—							
25%	12	10	0				
45/50%	12	0	0				
75%	17	0	0				
Ferro-vanadium—							
35/50%	14/- lb. Va.						
Ferro-molybdenum—							
70/75% carbon-free	4/9 lb. Mo.						
Ferro-titanium—							
20/25% carbon-free	9d. lb.						
Ferro-phosphorus, 20/25%	£21 to £22						
Ferro-tungsten—							
80/85%	6/- lb. (nom.)						
Tungsten metal powder—							
98/99%	6/1½ lb. (nom.)						
Ferro-chrome—							
2/4% car.	34	15	0				
4/6% car.	24	5	0				
6/8% car.	24	0	0				
8/10% car.	24	0	0				
Ferro-chrome—							
Max. 2% car.	36	0	0				
Max. 1% car.	38	5	0				
Max. 0.5% car.	41	0	0				
70% carbon-free	10d. lb.						
Nickel—99.5/100%	£180 to £185						
"F" nickel shot	£165	0	0				
Ferro-cobalt, 98/99%	8/6 to 8/9 lb.						
Metallic chromium—							
96/98%	2/5 lb.						
Ferro-manganese—							
76/80% loose	£18	15	0	to 19	5	0	
76/80% packed	£19	15	0	to 20	5	0	
76/80% export	£22	0	0				
Metallic manganese—							
94/96% carbon-free	1/3 lb.						

Per ton unless otherwise stated, basis 2-ton lots.

SCRAP

	£	s.	d.		£	s.	d.
South Wales (West)—							
Heavy steel, best	3	8	9	to 3	11	3	
Mixed iron and steel	3	6	9	to 3	9	3	
Heavy cast iron	3	8	9	to 3	11	3	
Good machinery				3	12	6	
Cleveland—							
Heavy steel, best	3	7	0	to 3	9	6	
Steel turnings	2	13	0	to 2	15	6	
Heavy cast iron				4	0	0	
Heavy machinery				4	5	0	
Midlands—							
Short heavy steel				3	15	0	
Light cast-iron scrap				3	2	6	
Heavy wrought iron	4	0	0	to 4	5	0	
Steel turnings	2	6	3	to 2	8	9	
Scotland—							
Heavy steel, best	3	5	0	to 3	7	6	
Ordinary cast iron	4	0	0	to 4	2	6	
Cast-iron borings	2	0	6	to 2	3	0	
Wrot-iron piling	4	5	0	to 4	7	6	
Heavy machinery				4	6	6	

London—Merchants' buying prices, delivered yard.

	£	s.	d.
Copper (clean)	33	0	0
Brass	23	0	0
Lead (less usual draft)	15	0	0
Tea lead	13	0	0
Zinc	7	10	0
New aluminium cuttings	67	0	0
Braziery copper	30	0	0
Gunmetal	33	0	0
Hollow pewter	130	0	0
Shaped black pewter	90	0	0

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	3s. 6d.
Finished bars, 18% tungsten	4s. 6d.

Per lb. d/d buyers' works.

PIG-IRON*

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	111/6
,, No. 3	109/-
,, No. 4	108/-
Forge No. 4	108/-
Hematite No. 1	133/-
Hematite M/Nos.	132/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	133/-
,, d/d Birm.	144/6
Malleable iron d/d Birm.	160/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	110/-
,, No. 3 fdry.	111/-
Northants forge	107/6
,, fdry. No. 3	108/6
,, fdry. No. 1	111/6
Derbyshire forge	110/-
,, fdry. No. 3	111/-
,, fdry. No. 1	114/-
Scotland—	
Foundry, No. 1, f.o.t.	120/6
,, No. 3, f.o.t.	118/-
Cleveland No. 3, Glasgow	112/-
,, ,, Falkirk	109/-
Scottish hem. M/Nos. d/d	133/-
Sheffield (d/d district)—	
Derby forge	107/6
,, fdry. No. 3	108/6
Lincs forge	107/6
,, fdry. No. 3	108/6
W.C. hematite	138/6
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	114/-
Staffs fdry. No. 3	114/-
Northants fdry. No. 3	112/6
Cleveland fdry. No. 3	114/-
Glengarnock, No. 3	141/-
Clyde, No. 3	141/-
Monkland, No. 3	141/-
Eglinton, No. 3	141/-
Gartsherrie, No. 3	141/-
Shotts, No. 3	141/-

(* Prices of hematite and basic pig-iron, and of foundry and forge iron with a phosphoric content of not less than 0.75 per cent., are subject to a rebate of 5s. per ton under certain conditions.)

FINISHED IRON AND STEEL

Usual district deliveries.

[A rebate of 15/- per ton for steel sections, plates and joists is obtainable in the home trade under certain conditions.]

Iron—	£	s.	d.		£	s.	d.
Bars (cr.)	13	5	0	to 13	15	0	
Nut and bolt iron	11	12	6	to 12	2	6	
Hoops				14	2	6	
Marked bars (Staffs) f.o.t.				15	15	0	
Gas strip				14	2	6	
Bolts and nuts, ¾ in. × 4 in.				17	10	0	and up
Steel—							
Plates, ship, etc.	11	8	0	to 11	10	6	
Boiler plts.	11	18	0	to 12	0	6	
Chequer plts.				13	0	6	
Angles				11	0	6	
Tees				12	0	6	
Joists				11	0	6	
Rounds and squares, 3 in. to 5½ in.				12	0	6	
Rounds under 3 in. to ⅜ in. (untested)				11	9	0	
Flats—8 in. wide and over				11	5	6	
,, under 8 in. and over 5 in.				11	10	6	
Rails, heavy				10	2	6	
Fishplates				14	2	6	
Hoops (Staffs)				12	4	0	
Black sheets, 24g. (4-t. lots)				15	15	0	
Galv. cor. shts. (,,)				18	10	0	
Galv. flat shts. (,,)				19	0	0	
Galv. fencing wire, 8g. plain				20	5	0	
Billets, soft, 100-ton lots				7	17	6	
Sheet bars				7	15	0	
Tin bars				7	15	0	

PHOSPHOR BRONZE

Per lb. basis

Strip	10¾d.
Sheet to 10 w.g.	11¼d.
Wire	12¾d.
Rods	13¼d.
Tubes	18¼d.
Castings	15d.

Delivery 3 cwt. free.
10% phos. cop. £33 above B.S.
15% phos. cop. £38 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	8d. to 1/2
Rolled—	
To 9 in. wide	1/2 to 1/8
To 12 in. wide	1/2½ to 1/8½
To 15 in. wide	1/2½ to 1/8½
To 18 in. wide	1/3 to 1/9
To 21 in. wide	1/3½ to 1/9½
To 25 in. wide	1/4 to 1/10
Ingots for spoons and forks	8d. to 1/4½
Ingots rolled to spoon size	11d. to 1/7½
Wire round—	
to 10g.	1/5½ to 2/0½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/4½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	25.84
No. 2 foundry, Valley	24.00
No. 2 foundry, Birm.	20.38
Basic, Valley	23.50
Malleable, Valley	24.00
Grey forge, Valley	23.50
Ferro-mang. 80%, seaboard	102.50
O.-h. rails, h'y, at mill	42.50
Billets	37.00
Sheet bars	37.00
Wire rods	47.00
	Cents.
Iron bars, Chicago	2.40
Steel bars	2.45
Tank plates	2.25
Beams, etc.	2.25
Skelp, grooved steel	2.10
Steel hoops	2.40
Sheets, black, No. 24	3.15
Sheets, galv., No. 24	3.80
Wire nails	2.75
Plain wire	2.90
Barbed wire, galv.	3.40
Tinplates, 100-lb. box	$5.35

COKE (at ovens)

Welsh foundry	42/6
,, furnace	37/6
Durham foundry	39/6
,, furnace	32/6
Scottish foundry	42/6
,, furnace	40/-

TINPLATES

f.o.b. British Channel ports.

I.C. cokes	20×14 per box		22/6
,,	28×20 ,,		45/-
,,	20×10 ,,		32/4
,,	18¾×14 ,,		23/5
C.W.	20×14 ,,		20/-
,,	28×20 ,,		42/6
,,	20×10 ,,		28/8
,,	18¾×14 ,,		20/9

SWEDISH CHARCOAL IRON & STEEL

	£	s.	d.		£	s.	d.
Pig-iron	£11	0	0	to £12	0	0	
Bars-hammered, basis	£20	0	0	to £22	0	0	
Bars and nail-rods, rolled, basis	£19	0	0	to £20	0	0	
Blooms	£18	0	0	to £19	0	0	
Keg steel	£30	0	0	to £35	0	0	
Faggot steel	£20	0	0	to £25	0	0	
Bars and rods dead soft st'l	£19	0	0	to £20	0	0	

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 19.39 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

			£	s.	d.		
Mar.	17	..	40	13	9	dec.	1/3
,,	18	..	40	11	3	,,	2/6
,,	21	..	40	7	6	,,	3/9
,,	22	..	40	0	0	,,	7/6
,,	23	..	39	3	9	,,	16/3

Electrolytic Copper

			£	s.	d.		
Mar.	17	..	44	5	0	dec.	5/-
,,	18	..	44	5	0	No change	
,,	21	..	44	0	0	dec.	5/-
,,	22	..	44	0	0	No change	
,,	23	..	43	0	0	dec.	20/-

Standard Tin (cash)

			£	s.	d.		
Mar.	17	..	184	12	6	dec.	7/6
,,	18	..	184	10	0	,,	2/6
,,	21	..	184	10	0	No change	
,,	22	..	185	10	0	inc.	20/-
,,	23	..	184	10	0	dec.	20/-

Tin (English ingots)

			£	s.	d.		
Mar.	17	..	184	12	6	dec.	7/6
,,	18	..	184	10	0	,,	2/6
,,	21	..	184	10	0	No change	
,,	22	..	185	10	0	inc.	20/-
,,	23	..	184	10	0	dec.	20/-

Spelter (ordinary)

			£	s.	d.		
Mar.	17	..	14	16	3	dec.	7/6
,,	18	..	14	17	6	inc.	1/3
,,	21	..	14	17	6	No change	
,,	22	..	14	13	9	dec.	3/9
,,	23	..	14	5	0	,,	8/9

Spelter (Electro, 99.9 per cent.)

			£	s.	d.		
Mar.	17	..	18	13	9	dec.	7/6
,,	18	..	18	13	9	No change	
,,	21	..	18	13	9	,,	,,
,,	22	..	18	10	0	dec.	3/9
,,	23	..	18	1	3	,,	8/9

Lead (soft foreign, prompt)

			£	s.	d.		
Mar.	17	..	16	11	3	inc.	2/6
,,	18	..	16	17	6	,,	6/3
,,	21	..	17	2	6	,,	5/-
,,	22	..	16	15	0	dec.	7/6
,,	23	..	16	1	3	,,	13/9

Lead (English)

			£	s.	d.		
Mar.	17	..	18	10	0	No change	
,,	18	..	19	0	0	inc.	10/-
,,	21	..	19	5	0	,,	5/-
,,	22	..	18	15	0	dec.	10/-
,,	23	..	18	0	0	,,	15/-

AVERAGE MONTHLY PRICES OF STEEL BOILER PLATES IN ENGLAND

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1901	9 5 0	9 5 0	8 15 0	8 10 0	8 10 0	7 10 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	8 3 11
1902	7 7 6	7 0 0	7 12 6	7 12 6	7 12 6	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 9 7
1903	7 10 0	7 10 0	7 15 0	7 5 0	7 5 0	7 5 0	7 5 0	7 0 0	7 0 0	7 0 0	7 0 0	6 17 6	7 3 11½
1904	6 12 6	6 15 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	6 18 11½	6 18 11½
1905	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 10 0	7 5 0	8 0 0	8 0 0	7 1 3
1906	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 10 0	8 0 10
1907	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 0 0	8 0 0	8 8 4
1908	7 10 0	7 10 0	7 10 0	7 5 0	7 5 0	7 5 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 3 9
1909	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	6 15 0	6 15 0	6 15 0	7 0 0	7 0 0	7 0 0	7 0 0	6 18 9
1910	7 0 0	7 0 0	7 1 3	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	7 10 0	7 10 0	7 10 0	7 5 1
1911	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 14 0	7 10 4
1912	7 18 9	8 0 0	8 0 0	8 7 6	8 10 0	8 10 0	8 10 0	8 15 0	8 16 3	9 0 0	9 2 0	9 5 0	8 11 2½
1913	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	8 19 0	8 15 0	8 5 0	7 15 0	7 15 0	8 17 0
1914	7 15 0	7 15 0	7 13 9	7 10 6	7 5 0	7 0 0	7 0 0	8 0 0	8 2 6	8 5 0	8 5 0	8 5 0	7 15 11½
1915	8 14 0	9 10 0	9 17 6	10 10 0	10 10 0	11 0 0	11 0 0	11 0 0	11 0 0	11 4 0	12 0 0	13 0 0	10 15 5½
1916	13 0 0	13 0 0	13 0 0	12 15 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 12 11
1917	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0
1918	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0
1919	13 0 0	15 0 0	15 0 0	15 0 0	19 5 0	19 17 6	21 0 0	21 10 0	21 10 0	21 10 0	21 15 0	23 10 0	18 9 9
1920	26 0 0	28 0 0	28 5 0	28 10 0	29 5 0	30 0 0	30 0 0	30 0 0	30 10 0	31 0 0	31 0 0	31 0 0	29 9 2
1921	30 5 0	29 0 0	25 0 0	25 0 0	25 0 0	23 0 0	21 0 0	20 10 0	19 0 0	17 10 0	16 0 0	14 16 0	22 1 9
1922	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	13 1 8	13 10 0	12 15 0	12 10 0	12 10 0	12 10 0	12 6 0	13 10 9
1923	12 8 9	13 6 0	14 0 0	14 0 0	14 0 0	14 0 0	13 12 6	13 0 0	13 0 0	13 0 0	13 0 0	13 10 0	13 9 1½
1924	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	14 0 0	14 0 0	13 11 0	13 5 0	13 5 0	13 10 11
1925	13 5 0	13 5 0	13 5 0	13 1 0	12 15 0	12 15 0	12 15 0	12 15 0	12 7 6	11 14 0	11 10 0	11 10 0	12 11 5½
1926	11 10 0	11 10 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 6 3
1927	11 5 0	11 5 0	11 5 0	11 5 0	11 2 6	11 0 0	11 0 0	11 0 0	10 16 0	10 10 0	10 10 0	10 10 0	10 19 0½
1928	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0
1929	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 12 6	10 10 0	10 5 0	10 1 3	10 1 3	10 1 3	10 1 7	10 6 8½
1930	10 2 9	10 3 5½	10 3 9	10 3 9	10 3 6	10 2 6	10 2 6	10 2 6	10 2 2½	9 19 6	9 16 3	9 16 3	10 1 6½
1931	9 15 0	9 15 0	9 15 0	9 10 11	9 6 9	9 5 0	9 7 0	9 7 9½	9 8 9	9 5 9	9 5 6	9 0 6	9 9 4
1932	9 5 0	9 2 6	8 18 6	8 17 6	8 16 6½	8 16 3	8 16 3	8 16 3	8 16 3	8 16 3	8 16 3	8 16 3	8 17 10
1933	8 10 0	8 10 0	8 10 0	8 8 9	8 5 0	8 5 0	8 5 0	8 5 0	8 5 0	8 5 0	8 6 0	8 7 6	8 6 10½
1934	8 8 1½	8 10 7½	8 16 6	8 17 6	8 6 3	8 6 3	8 5 7½	8 5 0	8 5 0	8 5 0	9 5 0	9 5 0	8 11 0
1935	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0
1936	9 5 0	9 5 0	9 5 0	9 5 0	9 8 1½	9 17 6	9 17 6	9 17 6	9 17 6	9 17 6	9 17 6	9 18 1	9 12 7½
1937	10 0 6	10 0 6	10 0 6	10 0 6	11 18 0	11 18 0	11 18 0	11 18 0	11 18 0	11 18 0	11 18 0	11 18 0	11 5 6
1938	11 18 0	11 18 0	—	—	—	—	—	—	—	—	—	—	—

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MALLEABLE IRON FOUNDRY FOREMAN wanted for Yorkshire district. Experienced in bench, stumping machine and plate moulding. State age, wages and experience, in confidence. Only first-class men need apply.—Apply Box 848, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

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MATHER & PLATT, LTD., will shortly require a competent Superintendent for their new iron foundry at Park Works, Manchester, 10, and invite foundrymen with full experience in modern practice in all departments to apply for the position. Only men who are capable of producing the highest quality work will be considered.

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TENDER

METROPOLITAN WATER BOARD.

TENDER FOR THE SUPPLY OF STORES, ETC.

THE Metropolitan Water Board invite Tenders for the supply of the undermentioned stores and services for the period of twelve months commencing June 1, 1938.

Contract No.

1.—Bricks, firebricks, cement, etc.
8.—Iron and steel.
9.—Bolts and nuts, screws, files, shovels, steam tubes, etc.
12.—Fuel oil, lubricating oil, kerosene, motor spirit greases, etc.
19.—Iron, brass, gunmetal and other castings.
20.—G.M. stopcocks and ferrules, outlets and caps for fire hydrants.
22.—Timber (hard woods).
23.—Maintenance of weighing machines.

Tenders must be submitted on the official forms, which may be obtained from the Chief Engineer by personal application at the offices of the Board (Room 171) or upon forwarding a stamped addressed envelope (large).

Applicants should refer to the number of the Tender for which forms are required.

Tenders, enclosed in sealed envelopes, addressed to the Clerk of the Board and endorsed in the manner indicated in the Form of Tender, must be delivered at the offices of the Board (Room 122) not later than 12 o'clock Noon on Monday, April 11, 1938.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
173, Rosebery Avenue,
E.C.1.
March 17, 1938.

MACHINERY

TENSILE TESTING MACHINE (Second-hand) wanted. 15-20 tons; preferably Tangye Type, hand operated. State price and condition to:

CASTINGS LIMITED,
SELBORNE STREET, WALSALL.

NEARLY new latest type 40-in. by 30-in. by 16-in. draw Shockless Jolt Roll-over Tabor Moulding Machine—for disposal on account of change of programme. Also Boorman No. 3A Core-Blowing Machine with A.C. motor; practically new.—Box 846, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

LARGE stock of AIR COMPRESSORS, all sizes, suitable for sandblast plants and moulding machines.—A. HAMMOND, 14, Australia Road, Slough.

FOR SALE.—Two Zimmermann R.P.W.2 Pneumatic Jolt Squeeze Turnover Moulding Machines.—S. C. BILSBY, Crosswells Road, Langley Green, near Birmingham.

SAND MIXERS AND AERATORS.—The "Breakir" Centrifugal Machine is *THE* machine. Outputs 10 cwts. to 8 tons per hr.—W. BREALEY & Co., LTD., Station Works, Ecclesfield, Sheffield.

'Phone **98** Staines

35/38-H.P. Crossley Horizontal Diesel Oil Engine, new 1932.

2½- and 1½-ton Morris Overhead Hand Cranes.

Tilghman Vertical Belt-driven Air Compressor, 130 c.f. at 100 lbs. w.p.

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Sand or Paste Mixer, twin Z blades, pan 30 in. by 30 in. by 23 in.

HARRY H. GARDAM & CO., LTD.,
STAINES.

SANDBLAST PLANTS.

ROOMS size, 12 ft. by 12 ft., 12 ft. by 9 ft., and 6 ft. by 6 ft.

Barrels: 54 in. by 36 in.; 36 in. by 30 in.; 30 in. by 20 in., etc.

Cabinet: 6 ft. by 4 ft.; 4 ft. 6 in. sq. by 3 ft. 6 in. sq., and 30 in. dia.

Table: 9-ft. Guttman.

Air Compressors in stock to suit any of the above plants.

Sand Mills: 7 ft. 6 in., 7 ft., 6 ft., 5 ft. and 4 ft. dia. pans.

Cupolettes: 10 cwts., 15 cwts. and 20 cwts.

Cupolas: 2 and 3 tons.

Morgan Tilting Furnaces: 250 and 400 lbs.

Heavy D.E. Grinding Machine: wheels 24 in. by 4½ in.

Sand Rammers, Disintegrators and Mixers. Air Compressors, Blowers and Exhaust Fans. Moulding Machines, etc., etc.

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No. 7 Ajax Jolt Turnover and Pattern Drawer Moulding Machine, 7" dia. cyls., lifting cap. approx. 8 cwts. Height of jar, 1¼"; air consumption approx. 22 cub. ft. per min., pattern draw 14". Table 36" x 26". Work. pressure 80 lbs. per sq. in.

No. 6 Ajax Jolt Ram Pneumatic Rollover Moulding Machine, take 36" x 24" boxes.

Write for "Albion" Catalogue.

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FOUR centre-axis Morgan-type Oil-fired Tilting Furnaces for sale; 250/300 lbs. capacity, complete with new crucibles. Also several genuine Morgan Coke-fired Furnaces.—A. HAMMOND, 14, Australia Road, Slough.

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GENUINE Tabor squeeze and pattern-draw Moulding Machines for sale—two machines 14 in. by 16 in. size, one machine 16 in. by 16 in. size and one machine 20 in. by 20 in. size.

Two fully portable Tabor Moulding Machines, roll-over type, thoroughly reconditioned.

Genuine Macdonald Moulding Machines, sizes: 12 in. by 15 in., 30 in. by 24 in., 36 in. by 24 in., 48 in. by 24 in.; these are turn-over machines.

The above in first-class condition; for sale cheaply.

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NEW Dwarf Cupola, to melt 10 to 15 cwts. per hr. New Worm-geared Ladles, 5 tons, 25 cwts., 15 cwts. and 10 cwts. capacity. Ungeared Ladles, 15 cwts. and 10 cwts. capacity. Improved Cupola Spark Arresters.—T. DAVIES & SON, West Gorton, Manchester.

PUBLICATION

RYLAND'S DIRECTORY of the Coal, Iron, Steel, Tinplate, Metal, Engineering, Hardware and Allied Trades. 1938 Edition. Price 42s. cloth bound, 52s. leather. Order your copy now.—INDUSTRIAL NEWSPAPERS, LIMITED, 49, Wellington Street, Strand, London, W.C.2.

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PATTERNS.—Cleghorn & Co. have new premises at 198-200, Bath Road, Worcester, and are in a better position to cope with all classes of engineers' pattern. 'Phone 264.

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